Ympäristöministeriö
Miljöministeriet
Ministry of the Environment

National Air Pollution Control Programme 2030

PUBLICATIONS OF THE MINISTRY OF THE ENVIRONMENT | 2019:14

ym.fi

Publications of the Ministry of Environment 2019:14

National Air Pollution Control Programme 2030

Ministry of the Environment, Helsinki 2019

Ministry of the Environment

ISBN (PDF): 978-952-361-020-0

Layout: Government Administration Unit, Publications

Cover image: A winter's day in Arabianranta, Pirjo Ferin/YHA Image Bank

Helsinki 2019

Description sheet

Published by	Ministry of the Environment		25 June 2019
Title of publication	National Air Pollution Control Programme 2030		
Series and publication number	Publications of the Ministry of the Environment 2019:14		
Register number	YM 036:00/2017	**Subject**	Environmental protection
ISBN PDF	978-952-361-020-0	**ISSN (PDF)**	2490-1024
Website address (URN)	http://urn.fi/URN:ISBN:978-952-361-020-0		
Pages	96	**Language**	English
Keywords	Air pollution control, air quality, emissions, health impact, environmental impact, small-scale woodburning, agriculture, street dust, fine particulate matter		

Abstract

The European Union's revised NEC directive (2016/2284) lays down the obligation to prepare a National Air Pollution Control Programme (NAPCP) for member states. The NAPCP comprises the actions for realizing the emission reduction commitments laid down in the directive for emissions of sulphur dioxide, nitrogen oxides, volatile organic compounds, fine particulate matter and ammonia. The NAPCP includes a description of the current state of Finland's air pollution control (emissions, air quality, effects) and an estimate on the amount of pollution, the effects caused by it and what measures must be implemented by 2030.

The calculations made by the Finnish Environmental Institute show that Finland already meets the emission reduction obligations set by the directive with the previously agreed on measures set out in the energy and climate strategy and the action plan to reduce ammonia emissions from agriculture.

Air pollution continues to cause health hazards and environmental damage despite the fact that the emission reduction obligations are met. Due to this, the NAPCP includes measures to further improve air quality and reduce exposure to pollution. These measures are specifically related to emissions that are inhaled (small-scale woodburning and street dust, exhaust fumes) and, on the other hand, to the actions of other sectors that affect air quality.

The NACPC emphasizes the need to take air pollution control into account systematically in all planning and decision-making activities that affect air quality at all levels of decision-making. In particular the traffic, energy, climate, agriculture and land-use sectors, together with municipalities, can affect air quality. The benefits can be seen throughout the welfare sector. Joint projects, aimed at promoting carbon neutrality and public health, usually also improve air quality.

Publisher	Ministry of the Environment
Distributed by/ publication sales	Online version: julkaisut.valtioneuvosto.fi Publication sales: julkaisutilaukset.valtioneuvosto.fi

Kuvailulehti

Julkaisija	Ympäristöministeriö		25.6.2019
Julkaisun nimi	Kansallinen ilmansuojeluohjelma 2030		
Julkaisusarjan nimi ja numero	Ympäristöministeriön julkaisuja 2019:14		
Diaari/hankenumero	YM 036:00/2017	**Teema**	Ympäristönsuojelu
ISBN PDF	978-952-361-020-0	**ISSN PDF**	2490-1024
URN-osoite	http://urn.fi/URN:ISBN:978-952-361-020-0		
Sivumäärä	96	**Kieli**	englanti
Asiasanat	ilmansuojelu, ilmanlaatu, päästöt, terveysvaikutukset, ympäristövaikutukset, puun pienpoltto, maatalous, katupöly, pienhiukkaset		

Tiivistelmä

EU:n päästökattodirektiivi (2016/2284) velvoittaa jäsenmaita laatimaan kansallisen ilmansuojeluohjelman. Ilmansuojeluohjelma sisältää ne toimet, joilla direktiivissä asetetut rikkidioksidin, typenoksidien, haihtuvien orgaanisten yhdisteiden, pienhiukkasten ja ammoniakin ilmapäästöjen vähentämisvelvoitteet toteutetaan. Ilmansuojeluohjelmassa esitetään Suomen ilmansuojelun nykytila (päästöt, ilmanlaatu, vaikutukset) sekä arvio päästöistä, vaikutuksista ja tarvittavista toimista vuoteen 2030.

Suomen ympäristökeskuksen tekemien laskelmien mukaan Suomi toteuttaa päästökattodirektiivissä sille asetetut päästöjen vähentämisvelvoitteet jo sovituilla energia- ja ilmastostrategian ja maatalouden ammoniakkiohjelman toimenpiteillä.

Huolimatta päästövelvoitteiden noudattamisesta ilmansaasteet aiheuttavat edelleen terveys- ja ympäristöhaittoja. Tämän vuoksi ohjelma sisältää toimia, joilla ilmanlaatua voidaan edelleen parantaa ja altistumista vähentää. Nämä toimet koskevat erityisesti taajamien hengityskorkeuden päästölähteitä (puun pienpoltto ja katupöly, pakokaasut) ja toisaalta ilmanlaatuun vaikuttavia muiden sektorien toimia.

Ilmansuojeluohjelma painottaa sitä, että ilmansuojelu tulisi ottaa johdonmukaisesti huomioon kaikessa ilmanlaatuun vaikuttavassa suunnittelussa ja päätöksenteossa kaikilla päätöksenteon tasoilla. Ilmanlaatuun vaikutetaan erityisesti liikenne-, energia-, ilmasto-, maatalous- ja maankäytön sektoreilla ja kunnissa. Hyödyt näkyvät hyvinvointisektorilla. Yhteistyöhankkeet, jotka edistävät mm. hiilineutraaliutta ja kansalaisten terveyttä, parantavat yleensä myös ilmanlaatua.

Kustantaja	Ympäristöministeriö
Julkaisun jakaja/myynti	Sähköinen versio: julkaisut.valtioneuvosto.fi Julkaisumyynti: julkaisutilaukset.valtioneuvosto.fi

Presentationsblad

Utgivare	Miljöministeriet		25.6.2019
Publikationens titel	Nationellt luftvårdsprogram 2030		
Publikationsseriens namn och nummer	Miljöministeriets publikationer 2019:14		
Diarie-/ projektnummer	YM 036:00/2017	**Tema**	Miljövård
ISBN PDF	978-952-361-020-0	**ISSN PDF**	2490-1024
URN-adress	http://urn.fi/URN:ISBN:978-952-361-020-0		
Sidantal	96	**Språk**	engelska
Nyckelord	luftvård, luftkvalitet, utsläpp, hälsoeffekter, miljökonsekvenser, småskalig vedeldning, jordbruk, gatudamm, fina partiklar		

Referat

EU:s utsläppstakdirektiv (2016/2284) ålägger medlemsländerna att utarbeta nationella luftvårdsprogram. Luftvårdsprogrammet innefattar de åtgärder som krävs för att de åtaganden om minskning av utsläppen av svaveldioxid, kväveoxider, flyktiga organiska föreningar, fina partiklar och ammoniak som fastställts i direktivet ska fullgöras. Luftvårdsprogrammet innehåller en beskrivning av det aktuella luftvårdsläget i Finland (utsläpp, luftkvalitet, konsekvenser) och en bedömning av utsläppen, konsekvenserna och de behövliga åtgärderna fram till 2030.

Enligt Finlands miljöcentrals kalkyler kommer Finland redan med de åtgärder som angetts i energi- och klimatstrategin och i programmet för att minska jordbrukets ammoniakutsläpp att kunna fullgöra de åtaganden om utsläppsminskningar som fastställs för landet i utsläppstakdirektivet.

Även om åtagandena om utsläppsminskningar fullgörs kommer luftföroreningarna fortfarande att orsaka olägenheter för hälsan och miljön. Därför innehåller programmet åtgärder som ska bidra till bättre luftkvalitet och lägre exponering. Åtgärderna gäller framför allt utsläppskällor i andningshöjd i tätorterna (småskalig vedeldning och gatudamm, avgaser) men också sådana åtgärder inom andra sektorer som kan ha inverkan på luftkvaliteten.

I luftvårdsprogrammet framhävs att luftvården konsekvent bör beaktas i all planering och allt beslutsfattande som har inverkan på luftkvaliteten, och detta bör ske på alla beslutsnivåer. Beslut som påverkar luftkvaliteten fattas framför allt inom transport-, energi-, klimat-, jordbruks- och markanvändningssektorn och i kommunerna. Nyttan syns inom välfärdssektorn. Samarbetsprojekt som bl.a. främjar koldioxidneutralitet och den allmänna hälsan förbättrar i allmänhet också luftkvaliteten.

Förläggare	Miljöministeriet
Distribution/ beställningar	Elektronisk version: julkaisut.valtioneuvosto.fi Beställningar: julkaisutilaukset.valtioneuvosto.fi

Table of contents

Abstract

The National Air Pollution Control Programme and the implementation of emission reduction commitments

This national air pollution control programme extends to 2030. The programme includes the measures required for the implementation of the emission reduction commitments of the EU's directive on the reduction of national emissions of certain atmospheric pollutants (hereinafter referred to as the National Emission Ceilings Directive, 2016/2284, the NEC directive) as well as other measures required to improve air quality.

Finland's air pollution control policy aims at improving people's welfare by safeguarding a good state of the environment, including good air quality as well as protecting biodiversity and preventing the acidification and eutrophication of ecosystems. This goal contributes to implementing the obligation laid down in the Constitution of Finland for the public authorities to guarantee for everyone the right to a healthy environment.

The NEC Directive obligates the Member States to reduce the emissions of sulphur dioxide (SO_2), nitrogen oxides (NOx), fine particulate matter ($PM_{2.5}$), ammonia (NH_3), and non-methane volatile organic compounds (NMVOC). The commitments are a continuation of emissions reduction commitments set in the first NEC Directive. The target of the directive is to use the emission reduction measures to decrease premature deaths caused by air pollutants in Europe by nearly half by 2030 compared to the status in 2005. The directive requires for the Member States to draw up a national air pollution control programme on their emission reduction efforts.

The emission reduction commitments imposed by the NEC Directive for Finland are presented in Table 1. The commitments are given as percentages of the emissions of 2005. For demonstration purposes, Table 1 also includes calculations of the reduction commitments in tonnes based on current emission inventory data.

Table 1. Finland's old and new emission reduction commitments as emission reductions shown as percentages and the emission reduction commitments calculated based on these expressed in kilotonnes (kt).

Pollutant	Old commitments for 2010–2019	Emissions in 2005 in kilotonnes used as the basis of the new commitments	New commitments for 2020–2029	New commitments as of 2030
SO_2	110kt	70kt	-30% (49 kt)	-34% (46.2 kt)
NO_x	170kt	205kt	-35 % (133.3 kt)	-47% (108.7 kt)
NMVOC	130kt	145kt	-35% (94.3 kt)	-48% (75.2 kt)
NH_3	31kt	37kt	-20 % (31 kt)	-20% (31 kt)
$PM_{2.5}$	-	28kt	-30 % (19.6 kt)	-34% (18.5 kt)

According to calculations by the Finnish Environment Institute, the emission reduction commitments laid down in the NEC Directive are accomplished with the measures agreed in the implementation of the energy and climate strategy and the action plan to reduce ammonia emissions from agriculture as well as the implementation of sector-specific emission limit regulations that are already in place and decided upon. In addition, further measures planned in the medium-term climate change policy plan for the reduction of greenhouse gas emissions will also increase the efficiency of the efforts to reduce air pollutant emissions.

The impacts of air pollutants

In general, Finland has good air quality. Despite this, the harm caused by air pollution is significant. Each year, air pollution causes 1,600–2,000 premature deaths in Finland. Even though both long-range transboundary emissions and emissions originating from domestic sources are set to significantly decline by the year 2030 as a result of the EU's climate and air pollution control policy, the number of premature deaths is projected to only drop by 10% from 2015 to 2030 based on specialist assessments. This is caused by population growth and ageing as well as constant urbanisation. Even after a reduction in the long-range transboundary emissions, there remain emissions caused by small-scale burning of wood and street dust from road traffic, which emerge near breathing height and continue to be partly unregulated.

The adverse health effects caused by air pollutants largely (64%) result from fine particulate matter ($PM_{2.5}$), which includes carcinogenic compounds and heavy metals. Fine particulate matter is transported via air to all parts of the respiratory system and cause direct allergic, immunological and toxic effects on the lungs, and is also partly absorbed in the blood circulation and further transported to other parts of the body, such as the myocardium and the brain. While the impacts of other air pollutants are also severe, they are less significant compared to those of fine particulate matter.

In Finland, areas vulnerable to acidification are estimated to cover less than one per cent of the total surface area of ecosystem, while the areas vulnerable to eutrophication are estimated to cover three per cent of this.

Measures contained by this programme on improving air quality and reducing exposure

Even if the commitments set in the NEC Directive are reached, air pollution will continue to cause adverse health and environmental effects in 2030. As a result, this National Air Pollution Control Programme includes measures for reducing the pollutant emissions and concentrations to a level even lower than that required under EU legislation.

The measures are particularly concerned with the emissions sources at breathing height in urban areas (small-scale burning of wood, street dust), and including air quality to all the planning, decision-making and implementation that affects air quality. Several other measures promoting air pollution control are also suggested. These include developing communications in different forms, influencing work at the EU and international levels, and spreading information about the costs of the adverse effects caused by air pollution.

The responsibility for carrying out the measures lies with an extensive group of national, regional and local agents. Key operators include different ministries (Ministry of the Environment, Ministry of Social Affairs and Health, Ministry of Economic Affairs and Employment, Ministry of Transport and Communications, Ministry of Finance, Ministry of Agriculture and Forestry, Ministry of Education and Culture), ELY Centres, National Supervisory Authority for Wellfare and Health, Traficom, municipalities, Helsinki Region Environmental Services Authority HSY, research institutes (Finnish Environment Institute, National Institute for Health and Wellfare, FMI), equipment manufacturers and different organisations (incl. the Central Association of Chimney Sweeps, Organisation for Respiratory Health, Finnish Fireplace Association).

Small-scale burning of wood

Small-scale burning of wood is the largest emission source for fine particulate matter in Finland, causing around half of domestic fine particulate matter emissions. According to estimates, exposure to the particulate matter caused by small-scale burning of wood causes around 200 premature deaths in Finland each year. In the future, the emissions from other sources have been projected to be significantly reduced under current legislation, while the emissions from small-scale burning of wood appear to remain at the current level or only slightly decline. The effects of the two Commission Regulations (2015/1185 and 2015/1189) based on Ecodesign Directive, which will enter into force in 2020 and 2022, on emissions originating from small-scale burning of wood have been

estimated to be fairly modest by the year 2030. This is due to the fact that heat-retaining fireplaces are slowly renewed in Finland and as sauna stoves fall outside the scope of the directive. In other words, additional measures must be taken at the national level to reduce the adverse health effects caused by small-scale burning of wood. Small-scale burning of wood is also the clearly biggest source of black carbon emissions in Finland.

The following measures are presented for preventing harm caused by small-scale burning of wood:

- Enhancing guidance by information aimed at citizens and other agents
- Reducing the harm caused by polluting wood-fired sauna stoves
- Improving the efficiency of the prevention of smoke hazards

Road transport

The adverse air quality effects of road transport are caused by exhaust emissions and street dust. The harms can be reduced by affecting the energy efficiency of transport systems, the energy efficiency of vehicles, replacing fossil oil based fuel with electricity and gas, and regulating exhaust gas emissions. In addition to the emissions from fuel consumption, street dust causes adverse effects on health and comfort, which can be reduced by preventing street dust from forming.

The following measures are presented for preventing harm caused by road transport:

- Implementing the recommendations of the Problems with Dusty Roads in Built-up Areas project
- Enhancing the spread of the best street cleaning and maintenance practices to municipalities and contractors
- Setting the best practices as selection criteria for procurement activities used to select contractors
- Increasing guiding by information on the tyre choices best in terms of air quality and safety for motorists
- Investigating use restrictions on studded tyres in certain areas
- Supporting measures and suggestions concerning accelerating the renewal of the vehicle stock and increasing the share of vehicles with zero and low emissions in traffic
- Supporting measures reducing the number of kilometres driven in passenger cars in urban areas

Influencing air pollution control in the planning and decision-making of other sectors

In addition to technical emission reduction measures, a positive trend in air quality requires taking air quality systematically into account in other planning and decision-making affecting air quality, and as part of the assessment of the health and environmental impacts of the measures carried out in different sectors. From the viewpoint of air pollution control, the most significant sectors include the land use, planning, energy, climate, transport, agricultural and welfare sectors. Key strategies and programmes which should include examination of air quality include:

- National Energy and Climate Strategy (2017)
- Medium-term climate change policy plan (KAISU, 2017)
- Programme for the promotion of walking and cycling (Ministry of Transport and Communications, 2017)
- Interim report by the Transport Climate Policy working group: Carbon-free transport by 2045 – Paths to an emission-free future (Ministry of Transport and Communications, 2018).

Municipalities' means of influence for promoting air pollution control

According to Finland's legislation, municipalities play a key role in safeguarding good air quality at the local level. Among other things, municipalities monitor air quality in their territories, and use those results as basis for implementing the necessary measures for improving air quality when exceeding, or being at risk of exceeding, air quality limit values. However, the most significant means of influence are concerned with measures other than the actual decision-making regarding air quality monitoring. For instance, municipalities make decisions on land use, transport and energy production, which have a major impact on emissions, air quality and exposure.

The work promoting air pollution control should aim at utilising the programme and organisational structures formed for the purpose of combating climate change, as the agents involved in these are largely the same. The practical measures of air pollution control and work related to climate change both often take place at the municipal level. Municipalities are involved in a number of national and international programmes and networks which take measures to mitigate and adjust to climate change. The municipalities are also involved in networks that aim at sharing good practices in promoting welfare and health.

Key collaboration projects affecting the air pollution control by municipalities include the following:

- Energy Efficiency Agreements
- The implementation of the medium-term climate change policy plan (KAISU) in municipalities and regions ("KuntaKaisu") in 2017–2025
- The IlmastoKunnat ('Climate-friendly Municipalities') activities of the Association of Finnish Local and Regional Authorities
- The HINKU Forum (a network for climate change mitigation bringing together municipalities committed to ambitious CO2 reductions, products and services supporting the goal, and experts in the energy and climate sector)
- The Healthy Cities network
- Agreements on land use, housing and transport (MAL Agreements concerning the coordination of land use, transport and housing made by the state with the largest urban areas)
- Municipal strategy (for each local council term)

Other measures

Other suggested measures for promoting air pollution control include developing different forms of communications, improving knowledge base, and influencing the work conducted in the EU and internationally. Such measures include:

- Supporting the air pollution control efforts by municipalities
- Enhancing and developing the communications on air pollution control to be more customer-oriented in cooperation with other agents
- Developing websites about air quality and emissions to be more customer-oriented
- Promoting the improvement of the knowledge base with, e.g. an adverse effect cost project
- Participating in the WHO's scientific assessment for checking air quality guideline values
- Influencing the development of air quality guideline values in the EU to reduce long-range transboundary pollution

Monitoring the implementation and impacts

The implementation of the emission reduction commitments is monitored annually with the emission inventories and projections prepared and updated by the Finnish Environment Institute. The Air Pollution Control Programme must be updated if the monitoring indicates a failure to meet one or more emission reduction commitments or a threat thereof.

The monitoring of the ecological impacts of air emissions of sulphur and nitrogen as well as ozone stress required by the NEC Directive is a responsibility of the Finnish Environment Institute, ELY Centres, Natural Resources Institute Finland, Finnish Meteorological Institute and Ministry of the Environment. The Finnish Environment Institute publishes data on the monitoring of emissions and impacts through the public information network.

Municipalities and the Finnish Meteorological Institute primarily carry out the air quality monitoring conducted in Finland.

To support and follow the accomplishment of the measures presented in this Air Pollution Control Programme, the Ministry of the Environment will set up a monitoring network to which key actors in charge of the implementation of the programme will be invited. The implementation of the measures will also be assessed with separate studies in 2026 and 2031.

Introduction

Good air quality is important for people's health and comfort as well as the welfare or nature and preservation of the built environment. While air quality is generally good in Finland, there continues to be need to reduce air pollutant concentrations, particularly where exposure is highest, namely urban areas.

During the previous period spanning slightly over thirty years, air quality has improved as atmospheric emissions have been reduced, particularly in the industrial, energy and transport sectors as a result of international conventions, EU legislation, and also partly due to national statutes. The most important of these instruments have included the so-called Convention on Long-range Transboundary Air Pollution of the United Nations (UN)[1] and the protocols under the Convention as well as the sector-specific emission limit values laid down in EU legislation, and other obligations concerning emission abatement and air quality.

The EU's latest National Emission Ceilings Directive[2] on the reduction of emissions of certain atmospheric pollutants was adopted in December 2016. The Directive obligates the Member States to reduce the emissions of sulphur dioxide, nitrogen oxides, ammonia, fine particulate matter, and non-methane volatile organic compounds. Although respirable particles (PM_{10}) fall outside the scope of the emission reduction commitments of the NEC Directive, the Member States are required to annually report the volume of particulate matter emissions to the Commission. The commitments are a continuation of emissions reduction commitments set in the first National Emission Ceilings Directive[3]. The directive requires for the Member States to draw up a national air pollution control programme on their emission reduction efforts.

1 1979 Convention on Long-range Transboundary Air Pollution

2 Directive (EU) 2016/2284 of the European Parliament and of the Council of 14 December 2016, on the reduction of national emissions of certain atmospheric pollutants

3 Directive 2001/81/EC of the European Parliament and of the Council of 23 October 2001 on national emission ceilings for certain atmospheric pollutants

The target of the directive is to use the emission reduction measures to decrease premature deaths caused by air pollutants in Europe by nearly half by 2030 compared to the status in 2005.

This National Air Pollution Control Programme extends to 2030 and includes the measures used to fulfil the emission reduction commitments issued in the Directive as well as nationally required additional measures for improving air quality and reducing the number of people exposed to poor air quality.

Moreover, the programme investigates the development of black carbon and methane emissions as part of climate change mitigation, particularly in the Arctic region. No commitments on reducing emissions from these pollutants have been imposed in the NEC Directive. Nonetheless, black carbon emissions must be reported as part of the EU reporting of the NEC Directive. The emission reduction goals and recommendations by the Arctic Council are concerned with the reduction of black carbon emissions.

The preparation of the Air Pollution Control Programme has taken into account the strategies, programmes and projects implemented and underway in different policy sectors, such as energy and climate policy, transport and agriculture as well as the measures taken under these.

The Ministry of the Environment and a working group set up by the ministry on 13 December 2017 has been in charge of preparing this Air Pollution Control Programme. In addition to the Ministry of the Environment, the participants in the activities of the working group have included the Ministry of Economic Affairs and Employment, the Ministry of Transport and Communications, the Ministry of Social Affairs and Health, the Ministry of Agriculture and Forestry, the Finnish Environment Institute, the National Institute for Health and Welfare, the Finnish Meteorological Institute, the Uusimaa ELY Centre, the Association of Finnish Local and Regional Authorities, the Central Union of Agricultural Producers and Forest Owners, Finnish Energy, Finnish Forest Industries, the Chemical Industry Federation of Finland, Technology

Industries of Finland, the Finnish Petroleum and Biofuels Association, and Finnish Association for Nature Conservation. The Finnish Environment Institute was responsible for carrying out emission assessments.

The working group convened seven times. Additionally, the working group organised a workshop on small-scale burning of wood on 7 June 2018, a public hearing on the working group's draft proposals on 19 September 2018, and consulted a number of specialists. Stakeholders and members of the general public were given an opportunity

for stating their opinions on the proposals by the working group via the lausuntopalvelu.fi statement service.

Information about the Air Pollution Control Programme and its implementation will be widely provided through various communication channels. These include the website, Twitter and YouTube channel of the Ministry of the Environment and stakeholders, and events held by the ministry and its stakeholders.

The Government adopted the National Air Pollution Control Programme in the government plenary session held on 7 March 2019.

Used abbreviations

BaP	benzo[a]pyrene, a carcinogenic polycyclic aromatic hydrocarbon
BC	black carbon
CO	carbon monoxide
CH_4	methane
CLRTAP	the Convention on Long-Range Transboundary Air Pollution of the UN Economic Commission for Europe
NECD	National Emission Ceilings Directive
NH_3	Ammonia
NMVOC	non-methane volatile organic compounds
NO_2	nitrogen dioxide
NO_x	nitrogen oxides
O_3	ozone
PAH	polycyclic aromatic hydrocarbons
$PM_{2.5}$	fine particulate matter
PM_{10}	respirable particles
SO_2	sulphur dioxide
TRS	total reduced sulphur

Sulphur dioxide (SO_2)	Sulphur dioxide is a gas that causes irritation to the respiratory system and acidification of ecosystems. The majority of sulphur emissions originates from the burning of fuel with sulphur content in energy production. Sulphur emissions have been in steep decline since the 1980s. In the atmosphere, sulphur dioxide transforms into sulphate connected to the size category of fine particulate matter.
Nitrogen oxides (NO_x)	Nitrogen oxides irritate the respiratory system and cause eutrophication and acidification in ecosystems, and contribute to the formation of low atmospheric ozone. In Finland, nitrogen oxide emissions primarily originate from energy production and traffic. In the atmosphere, nitrogen oxides transform into sulphate connected to the size category of fine particulate matter.
Respirable particles (PM_{10})	Particulate matter with a diameter of less than 10 µm is referred to as respirable particles. The particles are transported to the lungs through respiratory air and cause major adverse health effects. PM10 particles consist of different substances and may contain e.g. harmful heavy metals and carcinogenic hydrocarbons. Street dust is a major domestic source of PM_{10}.
Fine particulate matter ($PM_{2.5}$)	Fine particulate matter refers to particles with a diameter of less than 2.5 µm which are transported deep into the respiratory bronchiole through respiratory air and are extremely harmful for health. PM2 particles consist of different substances and may contain e.g. harmful heavy metals and carcinogenic hydrocarbons. Fine particulate matter originates from energy production, particularly small-scale burning of wood and peat production as well as the fuels used in transport and the wear of tyres, brakes and road surfaces.
Ammonia (NH_3)	Ammonia causes the acidification and eutrophication of ecosystems. Agriculture, particularly the manure of bovine animals, is the largest domestic emission source.
Ozone (O_3)	Low atmospheric ozone is harmful to vegetation and human health. The volumes of nitrogen oxides and different hydrocarbons as well as sunlight contribute to the formation of ozone. In Finland, the concentrations are the highest in rural background areas.
Non-methane volatile organic compounds (NMVOC)	Non-methane volatile organic compounds contribute to the formation of low atmospheric ozone and emergence of secondary particulate matter. Non-methane volatile organic compounds are produced by incomplete combustion (particularly in small fireplaces), transport, industrial processes, the use of solvents, glues, paint and printing colours, and the distribution of petrol.
Methane (CH4)	Along with carbon dioxide, methane is one of the most significant greenhouse gases. Methane is generated when organic matter is broken down in anoxic conditions, such as animals' dietary tract, peatland and landfills. Methane is also released in combustion processes.
Black carbon (BC)	Airborne black carbon refers to particulate matter strongly absorbing light with a high content of inorganic carbon. Black carbon originates from incomplete combustion. Emission sources include diesel vehicles, burning of wood, maritime transport, and long-range transboundary air pollution. Black carbon is in the size category of fine particulate matter.

1 Finland's air pollution control policy and its relationship with other policies

1.1 Objectives and focus areas

1.1.1 Air pollution control

In general, Finland has good air quality. Despite this, the harm caused by air pollution is significant (chapters 3.3 and 3.4). Efforts are taken to improve air quality by focusing emission reducing and other measures to those areas with the highest adverse effects, i.e. city centres and densely built urban areas. The planning of the implemented measures takes into account urban development and changes in the population age structure, such as a growth in the share of older population and other increases in urban dwelling, and related changes in living environments and operating modes.

In Finland, the limit values based on EU legislation are only sporadically exceeded. This does not guarantee that harms can be avoided. Indeed, there are local efforts to improve air quality particularly related to respirable particles, nitrogen dioxide and benzo(a)pyrene. The aim is to also reduce fine particulate matter, as this has significant adverse health effects despite the fact that concentrations are low.

1.1.1.1 Objectives

Finland's air pollution control policy aims at improving people's welfare by safeguarding a good quality of the environment, including good air quality, and protecting biodiversity and preventing the acidification and eutrophication of ecosystems. This goal contributes to implementing the obligation laid down for the public authorities to guarantee for everyone the right to a healthy environment laid down in section 20 (2) of the Constitution of Finland (731/1999).

The importance of this goal is also apparent in the Environmental Protection Act (527/2014), which pays special attention to safeguarding good air quality. The aim is to make everyone aware of the significance of a good environment in both increasing health and wellbeing and as a competitive factor, and make this a part of the operating culture.

The quality of the environment is improved by reducing the adverse effects caused by air pollutants on health and the environment. The adverse effects are reduced by preventing the emergence of emissions, reducing emissions with the best useful techniques, such as emission limit value regulation, and designing and implementing living environments where people's exposure to air pollutants is minimised. The prevention of adverse effects pays particular attention to reducing the emissions causing most adverse health effects. These mostly include emissions from traffic and small-scale burning of wood. Good air quality is pursued by incorporating good air quality into all design work affecting the environment as well as other decision-making (living environment planning, urban planning, community planning, neighbourhood planning, transport planning, energy planning).

According to the strategy of the Ministry of the Environment[4], the quality of the living environment is monitored and assessed using various indicators. The used indicators include fine particulate matter and black carbon emissions, nitrogen oxide emissions, and the satisfaction of inhabitants with the comfort of their residential area.

A further goal of Finland's air pollution control policy is to promote international measures for reducing air pollutant emissions. Finland sees it as important that other countries also reduce their emissions as a significant share of air pollutants in Finland consists of long-range transboundary air pollution.

1.1.1.2 Emission reduction commitments and objectives

Emission reduction commitments

The emission reduction commitments imposed by the National Emission Ceilings Directive for Finland are presented in Table 1. The commitments are given as percentages of the emissions of 2005. For demonstration purposes, Table 1 also includes calculations of the reduction commitments in tonnes based on current emission inventory data. The Member State specific emission reduction commitments have been determined in a manner ensuring the best possible cost efficiency at the EU level.

4 Strategy 2030 of the Ministry of the Environment

Table 1. Finland's old and new emission reduction commitments as emission reductions expressed as percentages and kilotonnes. The reduction commitment for ammonia emissions is 20% and the emissions may not exceed 31 kt.

Pollutant	Old commitments for 2010–2019	Emissions in 2005 in kilotonnes used as the basis of the new commitments	New commitments for the period 2020–2029	New commitments as of 2030
SO_2	110kt	70kt	-30% (49 kt)	-34% (46.2 kt)
NO_x	170kt	205kt	-35 % (133.3 kt)	-47% (108.7 kt)
NMVOC	130kt	145kt	-35% (94.3 kt)	-48% (75.2 kt)
NH_3	31kt	37kt	-20 % (31 kt)	-20% (31 kt)
$PM_{2,5}$	-	28kt	-30 % (19.6 kt)	-34% (18.5 kt)

Emission reduction objectives

Methane and black carbon emissions are reduced in accordance with the recommendations of the Arctic Council. In 2017, the Arctic Council[5] issued a recommendation for voluntary reduction of black carbon emissions jointly by 25–33 per cent from the level of 2013 by 2025. While the Arctic Council has not set an emission reduction target for methane, the Member States are requested to also significantly reduce methane emissions together and separately.

This programme also sets national objectives for reducing harm caused by street dust and small-scale burning of wood. The opportunities for reducing street dust and small-scale burning of wood and related impacts are assessed in chapter 6.

1.1.1.3 Air quality requirements and objectives

Under the Environmental Protection Act, the aim for all activities is to achieve a level of air quality where the quantity of hazardous or harmful substances or compounds in ambient air, or in the deposition of these, is not present at a level that would cause harm to health, nature and related functions, or issues such as the comfort of the environment. To reach this objective, government decrees have specified limit and target values for air quality. The majority of these values are based on EU legislation. The contents of these government decrees are further discussed in section 1.1.1.4.

The priority objective of the EU's General Union Environment Action Programme to 2020[6] is to safeguard the Union's citizens from environment-related pressures and risks to health and well-being, and to ensure that by 2020 ambient air quality in the Union has significantly improved, moving closer to WHO recommended levels. Therefore, the

5 The Member States of the Arctic Council: Canada, Denmark, Finland, Iceland, Norway, Russia, Sweden, USA

6 Decision No 1386/2013/EU of the European Parliament and of the Council on a General Union Environment Action Programme to 2020 'Living well, within the limits of our planet'

long-term target for Finland and all other EU Member States must be the achievement of WHO recommended air quality levels.

1.1.1.4 Regulation on air quality in the EU and Finland

Requirements for air quality have been set in EU instruments. In Finland, the instruments have been implemented at the national level with the Environmental Protection Act and the decrees issued under the Act. The purpose is to take air quality requirements and objectives into account in planning activities, monitoring the state of the environment, and carrying out supervisory measures related to the implementation. The requirements and objectives concerning the quality of the environment must also be taken into account as a scaling basis for the admissible emissions for activities subject to permit consideration.

Air quality instruments

In the EU, the Directive on ambient air quality[7] sets limits values for the sulphur dioxide, nitrogen dioxide, respirable particles (PM_{10}), fine particulate matter ($PM_{2.5}$), lead, carbon monoxide and benzene in ambient air, target values and long-term commitments for ozone, and the critical levels for sulphur dioxide and nitrogen oxides. The Directive also lays down provisions on the methods used in monitoring air quality and related quality objectives, the selection, placement and number of measurement sites, information provision to the general public, the preparation and implementation of air protection control plans and short-term action plans, and the submission of data to the European Commission. EU regulation on air quality also includes the so-called Heavy Metals Directive[8], which is concerned with arsenic, cadmium, mercury, nickel and polycyclic aromatic hydrocarbon (PAH compound) concentrations in ambient air.

The Directive on ambient air quality and the Heavy Metals Directive have been nationally implemented with the Environmental Protection Act[9] and the Government decree on air quality[10] (hereinafter referred to as the Air Quality Decree) and the Government decree relating to arsenic, cadmium, mercury, nickel and polycyclic aromatic hydrocarbons in ambient air[11] (hereinafter referred to as the Heavy Metals Decree).

7 Directive 2008/50/EC of the European Parliament and of the Council of 21 May 2008 on ambient air quality and cleaner air for Europe

8 Directive 2004/107/EC of the European Parliament and of the Council of 15 December 2004, relating to arsenic, cadmium, mercury, nickel and polycyclic aromatic hydrocarbons in ambient air

9 Environmental Protection Act 527/2014

10 Government decree on air quality 79/2017

11 Government decree relating to arsenic, cadmium, mercury, nickel and polycyclic aromatic hydrocarbons in ambient air 113/2017

The Air Quality Decree and Heavy Metals Decree lay down provisions on the limit and target values for air quality, the organisation of air quality monitoring, the reference methods used in air quality measurements, the quality objectives for the monitoring, the reporting of air quality data, and the provision of information and issue of warnings to the general public.

The limit values set for health protection by the Air Quality Decree are presented in Table 2, the target values and long-term objectives set for ozone for protecting vegetation in Table 3, and the critical levels of sulphur dioxide and nitrogen oxides for protecting ecosystems and vegetation in Table 4. The target values set for heavy metals and benzo(a) pyrene in the Heavy Metals Decree are presented in Table 5. The threshold limit values per day and hour have been statistically determined in that a certain amount of overstepping the numerical limit value is allowed within a calendar year. For the sake of comparison, Table 2 also presents the guideline values set by the WHO for the protection of health.

Compared to the WHO guideline values, the limiting values set by the EU for air quality are considerably higher for $PM_{2.5}$ particulate matter (annual average), sulphur dioxide (daily average) and PM_{10} particulate matter (annual average). For PM_{10} particles (daily average) and nitrogen dioxide (annual average), the EU norms are uniform with the guideline values of the WHO. WHO air quality guidelines are based on scientific evidence of the adverse health effects of air pollution. The limit values, which are legally binding, must take into account technical feasibility, and the costs of following the norms and resulting benefits. Based on WHO's instructions, allowing the exceedances of the limit values for a certain number of times can reduce the costs resulting from adhering to the values[12].

The Government decision on air quality guidelines and target value for sulphur deposition (480/1996)[13] also lays down provisions on air quality. No deadline has been set for the guidelines and they are mainly suitable for guiding the planning of land use, transport and construction. The guideline values are not further discussed in the present programme.

12 Air quality guidelines – Global update 2005 (p. 7) and "Guidance for setting air quality standards"

13 The Government decision on air quality guidelines and target value for sulphur deposition 480/1996

Table 2. Limit values set by the EU and WHO for air pollutants.

Substance	Time of calculating the average	Limit value µg/m³	Number of permitted exceedencess	Limit values valid since	WHO's guideline µg/m³
Sulphur dioxide (SO_2)	1 hour	350	24	1.1.2005	
	24 hours	125	3	1.1.2005	20
Nitrogen dioxide (NO_2)	1 hour	200	18	1.1.2010	200
	calendar year	40	-	1.1.2010	40
Carbon monoxide (CO)	8 hours	10 000	-	1.1.2005	
Benzene (C_6H_6)	calendar year	5	-	1.1.2010	
Lead (Pb)	calendar year	0,5	-	15.8.2001	
Respirable particulate matter (PM_{10})	24 hours	50	35	1.1.2005	50[1)]
	calendar year	40	-	1.1.2005	20
Fine particulate matter ($PM_{2.5}$)	calendar year	25	-	1.1.2010	10
	24 hours				25
	The national exposure ceiling as of 31 December 2015 20 µg/m³				[1)]99% compliance required, max. 3 oversteps

Table 3. Target values for ozone.

Basis	Time of calculating the average or statistic	Target value for 2010	Long-term target
Preventing and reducing adverse health effects	8 hours	120 µg/m³, which may be exceeded at most on 25 days per calendar year based on a three-year average	120 µg/m³ per a calendar year
Protecting vegetation	AOT40[1)]	18,000 µg/m³ h based on a five-year average	6000 µg/m³ h

[1)] *AOT40 (µg/m³h)* refers to ozone stress expressed as the cumulative sum of the hourly concentrations of ozone exceeding 80 µg/m³ and a 80 µg/m³ difference on a specified period calculated based on hourly values per day

Table 4. Critical levels for the protection of ecosystems and vegetation.

Substance	Time of calculating the average	Critical level µg/m³	Critical values valid since
Sulphur dioxide (SO_2)	calendar year and winter period (1 Oct–1 Mar)	20	15/08/2001
Nitrogen oxides (NOx)	calendar year	30	15/08/2001

Table 5. Target values for metals and benzo(a)pyrene.

Substance	Target value 1 Jan 2013
Arsenic (As)	6 ng/m³
Cadmium (Cd)	5 ng/m³
Nickel (Ni)	20 ng/m³
Benzo(a)pyrene ($C_{12}H_{20}$)	1 ng/m³

Operators' obligations

According to the Environmental Protection Act, operators shall have knowledge of the environmental impacts and risks of their operations, and of the management of these impacts and risks and ways to reduce adverse impacts. This knowledge requirement widely applies to the environmental impacts of activities caused by, for instance, atmospheric emissions. Knowledge of the environmental impacts is a prerequisite for the issue of an environmental permit. In practice, the knowledge requirement also means a commitment to follow the impacts of emissions on the state of the environment, and different supervision and measurement obligations. Moreover, operators shall organise their operations in such a way that environmental pollution can be prevented in advance. Where pollution cannot be fully prevented, it must be limited to the lowest level possible.

Municipalities' obligations

The Environmental Protection Act also lays down provisions on obligations binding municipalities. According to the Act, within its territory, the municipality shall see to the necessary monitoring of the state of the environment according to local conditions and ensure good air quality in its territory. Municipalities shall prepare and implement an air quality protection plan aimed at keeping pollution below the limit value in cases concerning the actual or potential exceedance of limit values. The air quality protection plan shall include information on issues such as the detected concentrations, the extent of the exceedance, and the extent of exposed population, emission volumes, emission sources, causes for exceeding the limit values, including stress from outside the territory, and information about the measures targeting transport and other emission-causing activities and the authorities in charge.

An air quality protection plan does not need to be drawn up in cases concerning the exceedance of limit values specified for particulate matter (PM_{10}) due to a particulate load caused by sanding or salting for the winter maintenance of roads and streets. In this case, the municipality may prepare, instead of an air quality protection plan, a report on the exceedance of the limit values, the reasons for the exceedance, and the measures required to lower concentrations. The requirements for the content of this document, known as a sanding report, are more concise than those set for the air quality protection plan; however, the report must also present data on the contents, the extent of the exceedance of limit values, the impacts of sanding and salting on concentrations, and measures taken to lower the concentrations.

Under the Environmental Protection Act, municipalities may issue necessary regulations concerning limitations and cancellation of activities aiming to safeguard air quality and enforce prepared plans. These regulations may not apply to an activity subject to a permit or registration. For instance, the municipality may change its traffic arrangements or even prohibit traffic in some areas. Moreover, municipalities may issue necessary general

regulations based on local circumstances, pertaining to the entire municipality or a part of it (municipal environmental protection regulations), which may apply to activities, limitations and structures that prevent emissions or the harmful impacts of them. These regulations may concern issues such as the use of solid fuel, including wood, in certain territories.

1.1.2 Climate policy and its impact on air pollution control

Air pollution control and climate policy have many points in common as their policy measures target the same emission sources. These include increasing the share of renewable and zero emission energy sources, cleantech solutions and increasing energy efficiency. On the other hand, some of their objectives, such as an increase in the use of bioenergy, if this increase is concerned with the small-scale burning of wood, and reducing air pollutant emissions, may contradict, and their harmonisation requires further measures. Air pollutant emissions, particularly black carbon, also have significant effects on the climate. It would be important to pay more attention to these climate impacts in climate policy assessments.

In addition to national energy and climate policy objectives, the content of Finland's climate policy is affected by the greenhouse gas emission reduction targets decided at the EU level (Table 6). These are divided into the emission trading sector (energy production and industry), which must meet the EU's joint obligation, and the sectors that fall outside the scope of the EU Emissions Trading System (e.g. transport, buildings, agriculture and waste), for which separate targets have been set for each Member State.

Table 6. The greenhouse gas emission reduction targets compared to the status in 2005.

	by 2020	by 2030
The EU's joint target (sectors in the EU Emissions Trading System)	- 21 %	–43 %
Target set for Finland (sectors outside the scope of the EU Emissions Trading System)	- 16 %	–39 %

The Climate Change Act[14] sets the frame for planning Finland's climate policy and monitoring its implementation. In turn, concrete policy measures have been determined in the national energy and climate strategy for 2030[15] and the medium-term climate change policy plan for 2030 (KAISU)[16]. The key measures influencing air pollution control in these instruments are listed in Appendices 3 and 4.

14 Climate Change Act (609/2015)

15 Huttunen R. (ed.) 2017. Government report on the National Energy and Climate Strategy for 2030. Publications of the Ministry of Economic Affairs and Employment 4/2017.

16 Ministry of the Environment 2017. Government Report on Medium-term Climate Change Plan for 2030 – Towards Climate-Smart Day-to-Day Living. Reports of the Ministry of the Environment 21/2017.

Climate Change Act

The Climate Change Act lays down provisions on the planning of climate change policy and the monitoring of climate targets. The goal of the planning system is to ensure the fulfilment of obligations under the treaties binding on Finland to reduce and monitor greenhouse gases, to mitigate climate change through national actions, and to adapt to climate change. The Act sets as the long-term target of reducing greenhouse gas emissions by 80% by 2050 compared to 1990 levels. The medium-term climate change policy plan for 2030 has been drawn up based on the planning system.

The National Energy and Climate Strategy for 2030

Finland's national energy and climate strategy determines measures with which Finland can accomplish the greenhouse gas emission reduction targets agreed in Prime Minister Sipilä's Government Programme 2015 and the EU by 2030 and progress towards an 80–95-per-cent cut in greenhouse gas emissions by 2050. According to the strategy, Finland will, for instance, phase out the use of black coal for energy with minor exceptions, increasingly switch to using biofuel, electricity and gas in transport, and increase the share of renewable energy in the country's total energy consumption.

According to the impact assessment of the energy and climate strategy, the volume of air pollutants is estimated to be reduced as a result of the policies proposed by the strategy, although the health risks related to air pollutants remain considerable. The policies reducing the number of total kilometres driven or increasing electric and gas cars are most significant in terms of reducing air pollutants, as the measures directly cut nitrogen oxide and fine particulate matter emissions. Nonetheless, the effect on air quality in cities ultimately depends on the development in the number of kilometres driven and regional division in this. A reduction in the total number of kilometres driven achieved through means such as transitioning to bicycle and pedestrian traffic as well as public transport, play a key role in improving air quality, particularly in cities.

In the context of small-scale burning of wood, the strategy policies will not significantly change the current status, i.e. the strategy introduces no national measures for the small-scale burning of wood. Nevertheless, the strategy notes that emissions can be affected through measures including technical standards, innovations, education, and instruction aimed at municipalities, but does not propose measures concerning these.

Medium-term climate change policy plan for 2030

The medium-term climate change policy plan for 2030, "Towards Climate-Smart Day-to-Day Living" (KAISU), outlines measures for reducing greenhouse gas emissions in the non-emissions trading sectors, namely transport, agriculture, building-specific heating, and waste management. The medium-term policy plan specifies and complements the emission reduction measures outlined in the energy and climate strategy. It also examines

links between different sectors and cross-cutting themes, such as air pollution control, the role of consumption and local climate action, and promotion of energy efficiency. Implementing the measures included in the policy plan has begun.

According to the policy plan's projection, the greatest potential for reducing emissions is in the area of transport, particularly road transport, where the intention is to replace fossil fuels with renewable and low-emission fuels and power sources. Transitioning to using electric transport is particularly significant from an air quality perspective. A further aim is to improve the energy efficiency of means of transport and the transport system. Combining different means of transport and reducing the number of kilometres driven are particularly important to achieving this goal.

In building-specific heating, the aim is to do away with oil heating, improve energy performance, and increase the use of renewable energy as well as to promote the clean combustion of pellets and firewood.

The majority of the measures also support improving air quality. The policy plan includes no measures that would cause an increase in small-scale burning of wood. An increase in the small-scale burning of wood for some other reason may also cause a surge in adverse effects on air quality unless this occurs simultaneously with an improvement in burner technology, fuel quality, and the competence of those using burning equipment. Small-scale burning of wood using current burner equipment also produces a significant amount of black carbon emissions, which particularly affect the warming of the Arctic region. There are currently no binging emission reduction commitments for black carbon emissions. The effects of black carbon and other air pollutants on the climate should nonetheless be taken into account as part of national climate plans.

This plan proposes measures that will create better conditions for developing public transport, cycling and walking, reducing the transport performances of private cars in particular, and improving the energy performance of buildings. Electric cars will reduce local emissions from fuel consumption, and, through this, improve air quality, health and comfort. A decline in the number of kilometres driven also reduces street dust emissions. Different subsidies and voluntary, informative and normative instruments are used to cut down traffic emissions.

1.1.3 The role and goals of municipalities in air pollution control

According to Finland's legislation, municipalities play a key role in securing good air quality at the local level (see section 4.2 for more detailed information concerning the Environmental Protection Act). Among other things, municipalities monitor air quality in their territories, and use this as basis for implementing the necessary measures for

improving air quality when exceeding, or being at risk of exceeding, maximum emission levels. However, the most significant means of influence are concerned with measures other than the actual decision-making regarding air quality monitoring. For example, municipalities make decisions on land use, transport and energy production, and these significantly affect emissions, air quality and exposure.

One of the key forms of decision-making affecting emissions is the municipalities' competence in issuing environmental permits for agents other than major industrial plants. The monitoring of these permits and registered operations also influences emissions. Under certain circumstances, municipalities may also affect emissions by issuing environmental protection regulations for preventing the contamination of the environment for activities other than those subject to a permit or registration.

All of the aforementioned decisions need to be supported by broad preliminary impact assessment carried out in cooperation between different sectors to also pay attention to the effects on air quality and people's health. Agreements on land use, housing and transport (MAL Agreements)[17] are used to support cooperation between municipalities in urban regions as well as municipalities and the state in steering community structures, and coordinating land use, housing and transport. District heating, cogeneration of heat and electricity, and district cooling provide energy efficient means optimal to local air quality for generating and distributing energy in densely built urban areas. Zoning, community planning and the placement of buildings also affect local exposure. In addition, there are measures related to local air pollution control, particularly those aiming to reduce street dust and emissions caused by small-scale burning of wood.

For each local council term, municipalities prepare a strategy determining the objectives for the coming years and the focus of the activities. Healthy living environments promoting welfare, and climate change mitigation are already visible in municipal strategies. Many municipalities have entered into voluntary agreements (incl. energy efficient contracts, social contracts in sustainable development) and joined networks that implement climate measures, including the HINKU forum[18] and the FISU network.[19] The work related to climate change carried out in many projects and networks also promotes air pollution control. The achievement of municipal strategy objectives is monitored through means such as the extensive wellbeing report, which is prepared once every local council term. Municipalities can include indicators related to the living environment and air quality in their wellbeing reports.

17 Agreements on land use, housing and transport (MAL) are agreements concluded by the state with the largest urban areas.

18 The HINKU Forum

19 The FISU Network

1.1.4 The role and goals of key sectors in air pollution control

In Finland, emissions end up in the air particularly from the industry and energy production, traffic and agriculture. Emissions are largely reduced in the country by implementing the EU's sector-specific emission regulation, and no additional sector-specific targets have been set. A separate action programme has been prepared only for reducing the ammonia emissions originating from agriculture.[20]

1.1.4.1 Industry and energy production

Industry and energy production continue to be major emission sources for sulphur dioxide, nitrogen oxides, fine particulate matter and volatile organic compounds. However, these emissions have been, and continue to be, in decline based on both direct emission commitments set to the activities as well as an indirect increase in the use of low emission and zero emission energy sources and improvement in the energy efficiency of production and consumption.

Key EU instruments concerning the industry and energy production include the so-called Industrial Emissions Directive[21] and Medium Combustion Plant Directive[22]. These Directives have been implemented in Finland with provisions concerning the environmental permit and registration procedure in accordance with the Environmental Protection Act, and government decrees containing the emission limit values and other detailed requirements[23].

The atmospheric emissions from industrial plants with significance from an environmental perspective, known as installations covered by the directive, are restricted by requiring the implementation of the best available techniques (BAT) in the environmental permit procedure. To fulfil the requirements for the best available techniques, the emission limits, monitoring and other permit regulations of the installations covered by the directive must be based on BAT conclusions. Under the Environmental Protection Act, the requirement for using the best available technique also concerns plants subject to an environmental permit smaller than the installations covered by the directive.

The atmospheric emissions from industry and energy production can also be reduced by increasing the share of energy production types with low or zero emissions. The national

20 Action programme for reducing the ammonia emissions originating from agriculture in Finland

21 Directive 2010/75/EU of the European Parliament and of the Council of 24 November 2010 on industrial emissions (integrated pollution prevention and control)

22 Directive 2015/2193 EU of the European Parliament and the Council of 25 November 2015 on the limitation of emissions of certain pollutants into the air from medium combustion plants

23 Government Decree on Limiting Emissions from Large Combustion Plants (936/2014), Government Decree on Environmental Protection Requirements for Medium-sized Energy Production Units (1065/2017) and Government Decree on Waste Incineration (151/2013)

energy and climate strategy and the medium-term climate change policy plan for 2030 both contain measures promoting this (see section 1.1.2 for more details).

Energy efficiency measures can also reduce the emissions from energy production. Improving energy efficiency reduced the need for producing energy. The Environmental Protection Act allows for the environmental permit to issue orders on energy efficiency to the installations covered by the directive. However, under the Act, the issuance of regulations is not required if the operator has entered into an energy efficiency agreement or joined other similar voluntary arrangement. In Finland, these voluntary energy efficiency agreements play a significant role, and they have become the primary means of promoting energy efficiency. The Energy Efficiency Agreement for Industries 2017–2025 covers the industrial, energy, and private service sector.

1.1.4.2 Transport

Transport is a major emission source for nitrogen oxides, volatile organic compounds, particulate matter, and carbon dioxide. Sulphur dioxide emissions no longer emerge in traffic. The exhaust emissions from vehicles have been reduced and will continue to be effectively cut through EU's legislation on different vehicles. However, a growth in traffic volume slows down the reduction of total emissions even though emissions per unit are reduced.

Efforts to reduce street dust have been less successful than cutting down the direct transport-related exhaust gas emissions. Street dust particularly emerges as an increase in respirable particle (PM_{10}) concentrations during spring. Municipalities combat street dust by cleaning streets and roads, and through dust binding efforts. They have managed to slightly cut down the concentrations from the peak level of the 1990s.

Currently, climate change mitigation is the main reason for developing transport systems and the vehicle stock. In addition to achieving climate goals, the Environmental Strategy for Transport[24] by the Ministry of Transport and Communications presents targets for reducing nitrogen oxides and particle emissions. The transport-related nitrogen oxide emissions should be reduced by 25 per cent, and particulate emissions by 20 percent, by 2020 compared to the status in 2011. The goal is that the cut in emissions will significantly improve the air quality of cities, and reduce the incidence of premature deaths and illness caused by poor air quality.

Most measures related to cutting carbon dioxide emissions, including a reduction in kilometres driven, development related to modes of transport and social structures, and a transition to electric and gas cars, will also reduce air pollutants, particularly

24 Environmental Strategy for Transport 2013–2020

nitrogen oxide and particulate matter emissions. Therefore, the measures primarily implemented for reasons pertaining to the climate also support decreasing the adverse health effects caused by poor air quality. By 2030, the goal is to have, in total, a minimum of 250,000 electric vehicles (fully electric vehicles, hydrogen-powered vehicles and rechargeable hybrids) and at least 50,000 gas-powered vehicles.[25] All of these measures will be carried out in the coming years as part of the implementation of different strategies.

The national energy and climate strategy and medium-term climate change policy plan (KAISU) determine measures for reaching national climate objectives (see 1.1.2). According to the strategy, Finland's traffic will increasingly switch to using biofuel, electricity and gas in transport, and increase the share of renewable energy in the country's total energy consumption.

The medium-term climate change policy plan proposes measures that will create better conditions for developing public transport, cycling and walking, reducing the transport performances of private cars in particular. The reduction in the kilometres driven will cut both exhaust gas emissions as well as street dust. Different subsidies and voluntary, informative and normative instruments are used to cut down traffic emissions. The implementation of the measures has been launched by reserving an appropriation of the Budget for purposes such as the construction of a vehicle charging infrastructure, a purchase subsidy for electric cars, and the promotion of walking and cycling.

The alternatives for developing transport are also discussed in the Carbon-free transport by 2045 report by the Transport Climate Policy working group[26]. The report presents three alternative scenarios for reaching the goal: developing services, using biofuel, and technological solutions[27]. While the effects on air quality of the three alternative scenarios have not been assessed, all of them are likely to improve air quality.

One of the most significant measures for improving air quality is the goal of transitioning from private car use to walking, cycling and using public transport. This goal is supported with a number of measures, such as the Programme for the promotion of walking and cycling[28] and the development of shared and versatile Mobility as a Service (MaaS) solutions. The aim of the Programme for the promotion of walking and cycling is that, by 2030, the total proportion of walking and cycling as a means of transport will increase from today's 30 per cent to at least 35–38 per cent. A more extensive service idea allows users in urban areas to receive mobility and transport services that correspond to

25 Government Report on Medium-term Climate Change Plan for 2030. Ministry of the Environment 21/2017.

26 Carbon-free transport by 2045

27 Carbon-free transport by 2045 – Paths to an emission-free future. Publications of the Ministry of Transport and Communications 9/2018.

28 Programme for the promotion of walking and cycling

their needs without a need for using or owning a private car by making use of market mechanisms.[29]

The limit values set at the EU level for the carbon dioxide emissions of passenger cars and vans, and heavy transport cause an indirect reduction in transport emissions.[30] Based on the current situation, the limit values for passenger cars and vans will be tightened by at least 15% for 2025 and at least 35% for 2030. The corresponding limits set for heavy transport are 15% for 2025 and at least 30% for 2030. The limit values are manufacturer-specific and calculated for the vehicles sold by the manufacturer. The better manufacturers succeed in reaching the limit values, the more profitable it is for manufacturers to develop especially vehicles with zero and low emissions.

1.1.4.3 Agriculture

The emission reduction commitments for airborne emissions originating from agriculture are based on the requirements laid down in the Convention on Long-Range Transboundary Air Pollution and the National Emission Ceilings Directive. The commitments are particularly concerned with reducing ammonia emissions. 90 per cent of ammonia emissions originate from agriculture. Finland has struggled to achieve sufficient ammonia emission cuts ever since 2010. To fulfil the obligations, the Ministry of Agriculture and Forestry and the Ministry of the Environment adopted the Action plan for reducing the ammonia emissions originating from agriculture in Finland[31] in 2017. The plan determines the measures required in reaching the commitment level set for ammonia emissions in 2020 by the National Emission Ceiling Directive. The action programme will be updated to concern the period 2021–2030 in 2019.

As agriculture is the most significant (over 90%) emission source for ammonia (NH_3), the commitment for a 20% emission cut in the NEC Directive for starting in 2020 compared to the emission status in 2005 primarily concerns agriculture.

According to the Environmental Protection Act (527/2014), an activity posing a risk of environmental pollution is subject to a permit. The regulation concerning activities subject to a permit is partly based on the Industrial Emissions Directive (installations covered by the directive), and partly purely national (national list of establishments). The permit requirement for animal shelters is based on animal husbandry in a production building. Animal husbandry also includes outdoor areas and pastures adjoined to the

29 see Göran Smitha, Jana Sochora, Steven Sarasini: Mobility as a service: Comparing developments in Sweden and Finland. Research in Transportation Business & Management 2018. In press.

30 COM/2018/143 and COM COM/2017/676

31 Action programme for reducing the ammonia emissions originating from agriculture in Finland (2018). Publications of the Ministry of Agriculture and Forestry 1/2018

animal shelter, and the storage, processing and utilisation of the manure, urine and waste water originating from the animal shelter. The environmental permit can issue regulations on restricting ammonia emissions.

The BAT conclusions for the intensive rearing of poultry or pigs (Commission Implementing Decision (EU) 2017/302) are applied in the environmental permit procedure of the installations covered by the directive. Under the Environmental Protection Act, the requirement for using the best available technique also concerns animal shelters subject to an environmental permit smaller than those covered by the directive.

The Government Decree on Limiting Certain Emissions from Agriculture (also known as the Nitrate Decree)[32]32 also contributes to the regulation of agriculture-related NH_3 emissions (requirements on manure storage and application, and the maximum amount of nitrogen fertiliser).

An environmental permit may contain orders stricter than those laid down in the Government Decree on Limiting Certain Emissions from Agriculture, for instance, concerning earthing (for example within 4 hours) and covering of manure storages (including existing manure storages). The permit may also determine that, for instance, slurry may only be applied by incorporation or that applying slurry should be avoided under windy conditions. As explained above, the provisions included in a permit must be based on the best available technique; however, the permit may not require the use of a specific technique.

The different forms of assistance of EU agricultural policy (Rural Development Programme for Mainland Finland 2014–2020) and related conditions affect issues such as the use rate and processing of manure and fertilisers, and related investments. Negotiations on the assistance for the period after 2020 (2021–2027) were launched in the summer of 2018.

1.1.4.4 Small-scale burning of wood

Small-scale burning of wood is the most significant emission source for fine particulate matter in Finland, causing around half of Finland's $PM_{2.5}$ emissions. While the emissions from other sources are projected to significantly decline as a result of currently valid legislation, emissions from small-scale burning of wood appear to remain at the current level or drop only slightly.

No quantitative goals or commitments have been set for reducing the emissions caused by small-scale burning of wood. The Commission Regulations implementing the Ecodesign Directive 2009/125/EC of the European Parliament and of the Council with

32 Government Decree on Limiting Certain Emissions from Agriculture 1250/2014

regard to ecodesign requirements for solid fuel local space heaters (2015/1185) and solid fuel boilers (2015/189), which will enter into force in 2020 and 2022, will slowly affect the volume of fine particulate matter emissions. The regulations do not apply to sauna stoves, which is the biggest individual emission source for small-scale burning of wood. Indeed, national measures are required for reducing emissions from small-scale burning of wood and related harm. The promotion of the correct use of fireplaces and local space heaters and preferring wood-burning sauna stoves with lower emissions have been found as particularly suitable, efficient and cost-effective approaches for reducing the adverse effects caused by small-scale burning of wood. Table 11 of section 6.2 of the present programme proposes related measures.

Small-scale burning of wood is also the clearly biggest source of black carbon emissions in Finland. Black carbon is a contributor to climate warming, particularly emphasised in the Arctic region (e.g. AMAP Assessment 2015). Cutting the emissions caused by small-scale burning of wood also reduces black carbon emissions.

1.1.5 Reduction of black carbon and methane emissions

The purpose of the reduction of black carbon and methane emissions is to slow down climate change by intervening in both carbon dioxide emissions as well as short-lived air pollutant emissions affecting climate.

The measures used to reduce black carbon emissions also cut fine particulate matter emissions, therefore improving air quality. The Arctic Council, to which Finland belongs, has issued a recommendation to reduce black carbon emissions by 25–33% by 2025 compared to the level in 2013.[33] The member countries[34] of the Arctic Council are committed to reporting data of their black carbon emissions, preparing projections of the development of emissions, and determining emission reduction measures.

The International Maritime Organisation (IMO) has negotiated on the black carbon emissions of watercraft in the Arctic region. In the spring of 2019, discussions will be launched on the measures for restricting the black carbon emissions of vessels.

No quantitative targets have been set for reducing methane emissions at the international or EU level. Methane emissions are reduced by waste management measures, such as banning the landfilling of organic waste. No commitments or targets reducing methane emissions have been set for agriculture.

33 Arctic Council Ministerial Meeting, 11 May 2017, Fairbanks, USA

34 Canada, Denmark, Finland, Iceland, Norway, Russia, Sweden and the United States

2 Responsibilities at the national, regional and local level

The areas of responsibility of key authorities and other agents involved in air pollution control in Finland are depicted in Table 7.

Table 7. Key authorities and other agents involved in air pollution control in Finland.

Agent	Responsibilities
Ministry of the Environment	Prepares the national objectives for air pollution control, participates in international cooperation, and develops and prepares legislation on air pollution control and other environmental protection. National focal point for the Convention on Long-Range Transboundary Air Pollution. National coordination of the medium-term climate change policy plan. Building-specific energy production and use, and the implementation of the Ecodesign Directive. policy, coordination
Ministry of Economic Affairs and Employment	Responsibility within the administrative branch, incl. the national energy and climate strategy, industry and energy policy measures. policy
Ministry of Social Affairs and Health	Responsibility within the administrative branch, incl. reducing the adverse health effects of air pollutants. policy
Ministry of Transport and Communications	Responsibility within the administrative branch, incl. reducing traffic emissions, transport policy measures. policy
Ministry of Agriculture and Forestry	Responsibility within the administrative branch, incl. reducing agriculture-related ammonia emissions. policy
Ministry of Finance	Responsibility within the administrative branch, financial steering measures related to cutting emissions, incl. fuel and transport taxes policy
Regional State Administrative Agencies (AVI)	Granting the environmental permits of the institutions under their competence (large and some medium-sized). implementation

Agent	Responsibilities
Centres for Economic Development, Transport and the Environment (ELY Centres)	Steering and promoting air pollution control in their regions Monitoring of the environmental permits granted by the state permit authority (AVI). Work related to air pollution control is particularly carried out in connection with the monitoring of energy production plants and industrial plants (monitoring of e.g. compliance with emission limit values and, if necessary, negotiating with operators on the measures necessary for cutting down emissions). implementation, monitoring
Other supervisory authorities with significance to the emissions of pollutants into the air under the Environmental Protection Act	Finnish Safety and Chemicals Agency and Traficom Market surveillance of paints and varnishes containing volatile organic compounds (VOCs), and combustion engines installed in machinery
Municipalities	The monitoring of air quality in urban areas, safeguarding and promoting local air quality, granting environmental permits to plants under their remit (small and some medium-size plants), monitoring the environmental permits and activities subject to registration they gave granted to plants (e.g. energy production), making decisions on town planning as well as on transport and energy production with significant effects on emissions, air quality and exposure, issuing environmental protection provisions to prevent environmental pollution for activities not subject to permits and registration implementation, monitoring
Specialist and research institutes	Finnish Meteorological Institute FMI: The monitoring of air quality outside urban areas, air quality modelling, research and reporting, a national reference laboratory for air quality, maintenance of the air quality section of a data system for environmental protection Finnish Environment Institute SYKE: Emissions scenarios and modelling of air pollutants, emission inventories, and reporting, research, impact assessment and monitoring, specialist reports for the preparation and implementation of national and international air pollution control legislation, tasks of a contact point for BAT exchange of information National Institute for Health and Welfare THL: Investigation of exposure to air pollutants and adverse health effects, impact assessment, supporting ministries, regional administration and municipalities in the subject area, international cooperation (particularly WHO) Natural Resources Institute Finland LUKE: Ecological impact monitoring of atmospheric emissions in woodland areas VTT Technical Research Centre of Finland LTD: Modelling and calculation of traffic emissions research, impact monitoring
Operators	Reduction and management of emissions from activities and related risks, supervision and reporting to the authorities, compliance with permit regulations (e.g. emission limit values) and environmental protection requirements laid down for activities subject to registration, provision of information, air quality monitoring in accordance with permit decisions carried out as joint monitoring with other agents and the municipality

3 The development of air pollution control measures, and air quality and other environmental impacts in the period 1990–2017

3.1 The development of emissions

The trend in Finland's atmospheric emissions (NO_x, NMVOC, SO_x, NH_3, $PM_{2.5}$, PM_{10}, CH_4 and black carbon) from the 1980s until 2017 is presented in Figures 1–3. The international maritime and air traffic has been excluded from the emission calculations. National emissions include the emissions originating from domestic water transport (inland waters and territorial waters) and aviation (domestic flights and take-offs and landings of international flights). There has been a considerable decline in the emissions, primarily caused by technological advancement rather than changes in consumer habits and manufacturing approaches. International conventions, the implementation of EU legislation as well as separate national legislation have influenced the drop in the emissions. Sulphur dioxide emissions have mostly declined as a result of measures by the industry (desulphurisation plant, fuel quality), nitrogen oxides as a result of measures related to transport (engine technology and catalytic converters in passenger cars) and energy production and industry (combustion and DeNOx technology), volatile organic compounds as a result of measures by the industry and transport, and particulate emissions as a result of measures by the industry (electrostatic precipitators) and transport. In the period 1990–2017, $PM_{2.5}$ emissions have been on average 64 per cent of the PM_{10} emissions (on a range of 59–74%). The trend in ammonia emissions is the consequence of changes in the number of animals in agriculture and measures concerning manure processing.

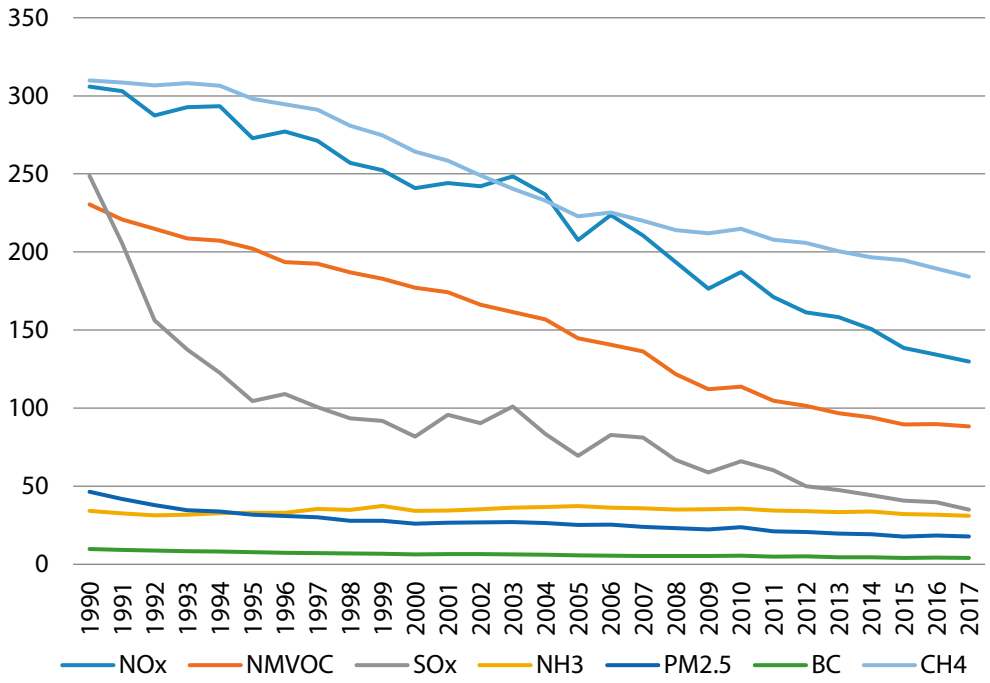
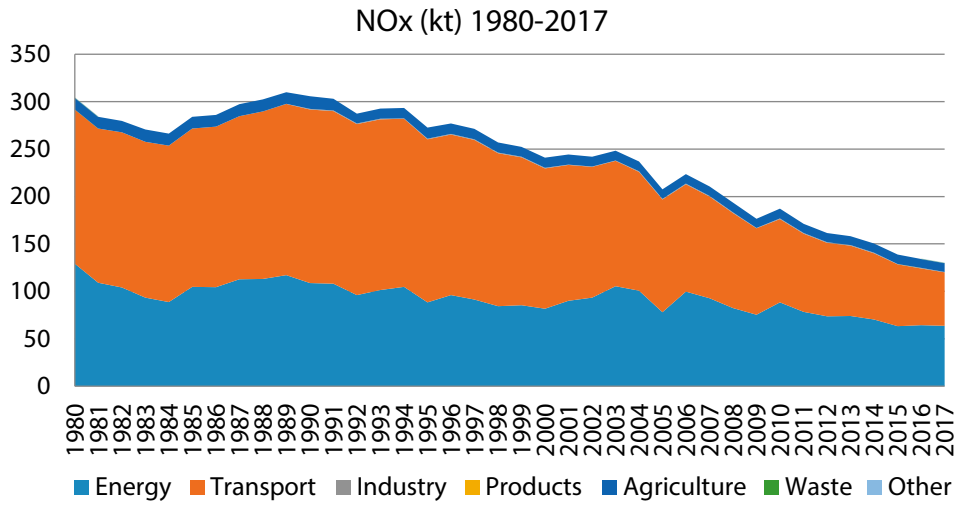
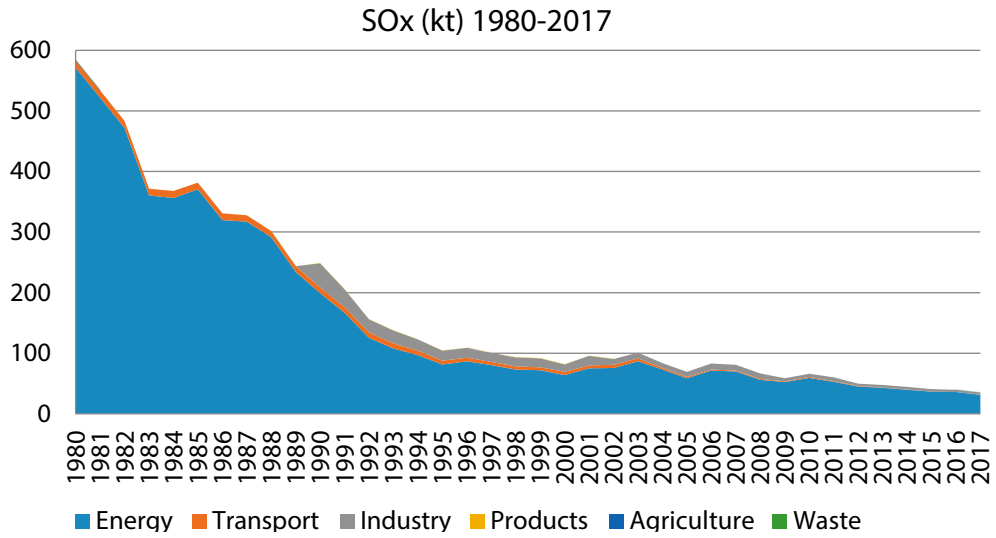
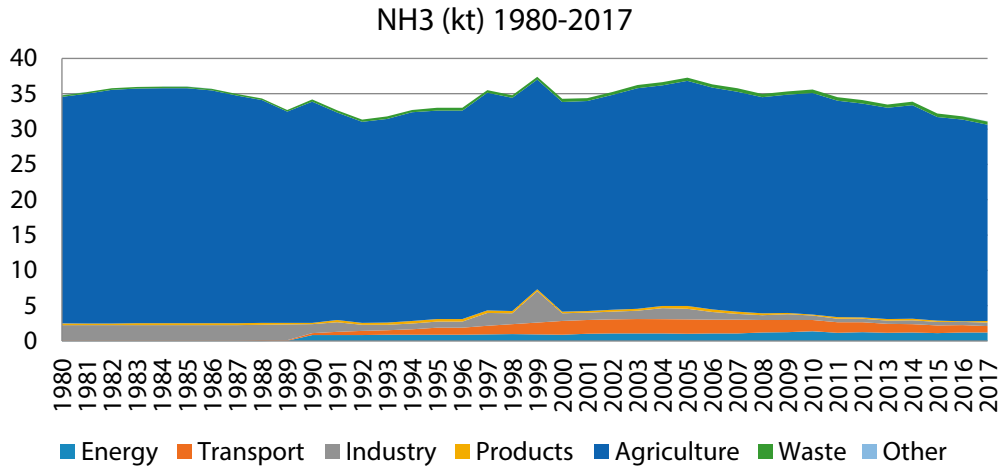


Figure 1. **Nitrogen oxide, sulphur oxide, volatile organic compound, ammonia, methane and $PM_{2.5}$ fine particulate matter emissions in Finland, 1980–2017 (kt).**


NOx (kt) 1980-2017
350
300
250
200
150
100
50
0
1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017
Energy
Transport
Industry
Products
Agriculture
Waste
Other


SOx (kt) 1980-2017
600
500
400
300
200
100
0
1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017
Energy
Transport
Industry
Products
Agriculture
Waste


NH3 (kt) 1980-2017
40
35
30
25
20
15
10
5
0
1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017
Energy
Transport
Industry
Products
Agriculture
Waste
Other

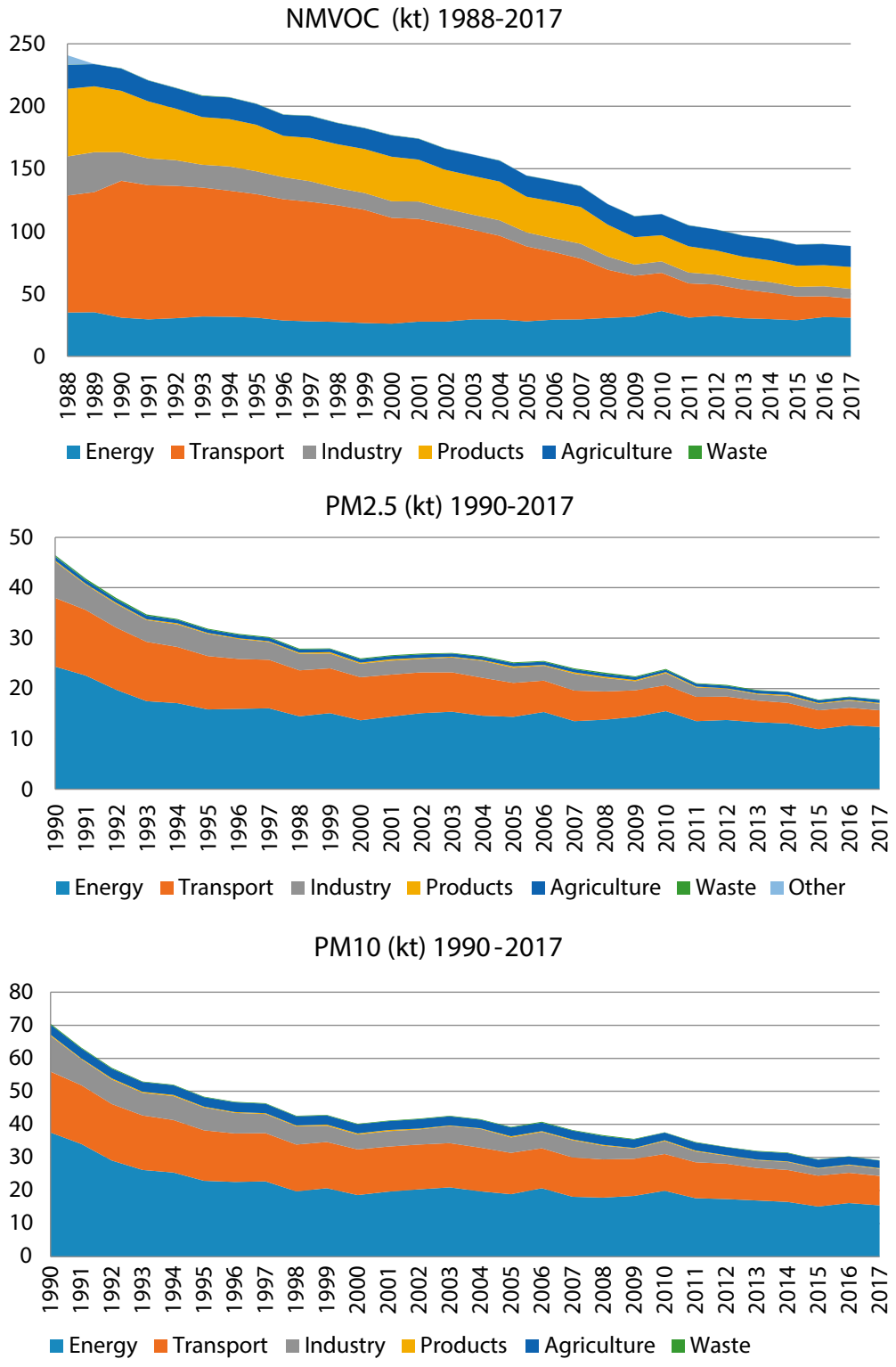


Figure 2. Trends in air emissions in Finland (NOx, SOx, NH_3, NMVOC, $PM_{2.5}$ and PM_{10}) (kt/a) per emission source. While the NMVOC emissions include NMVOC emissions originated from animals, these are not covered by the NEC Directive or included in the scenarios set out in chapter 5.

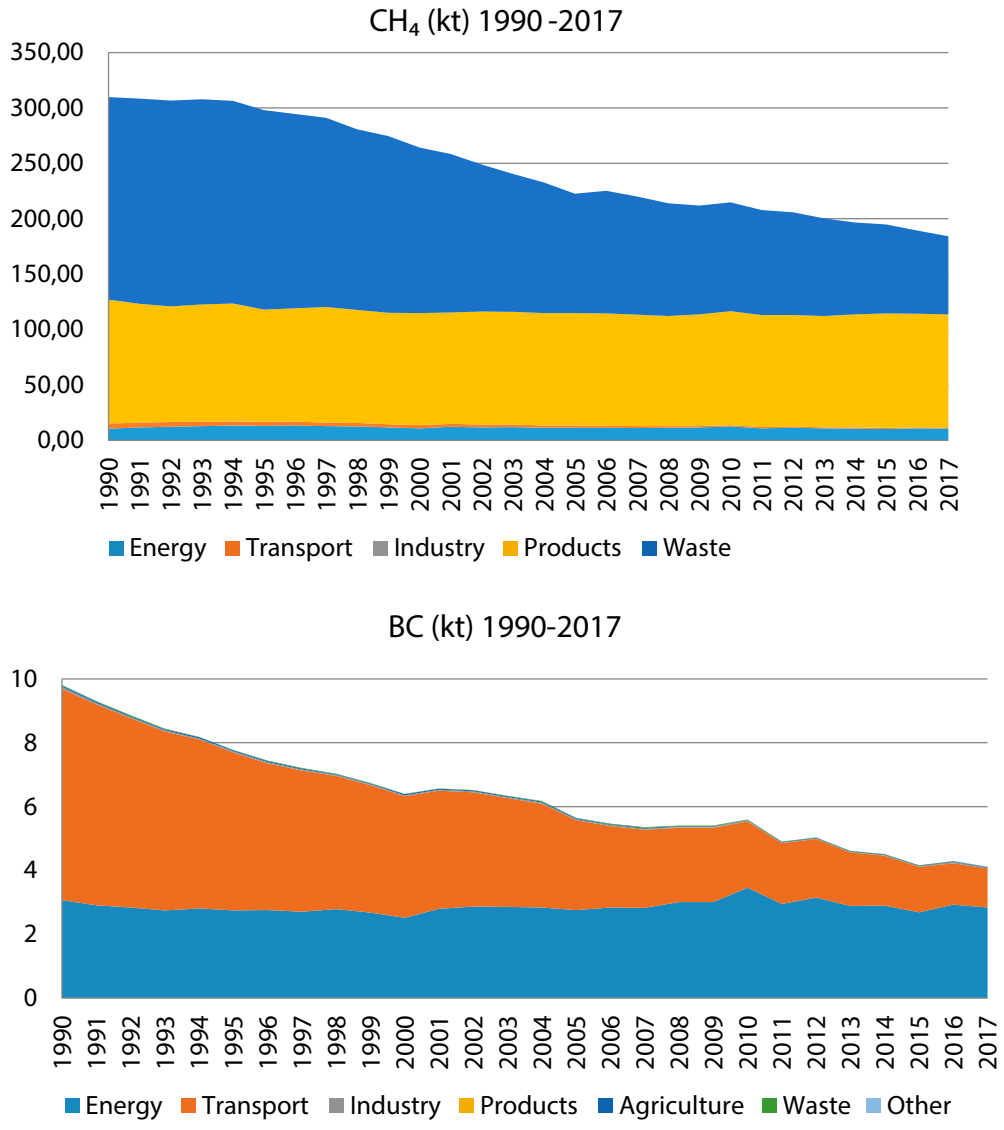


Figure 3. Trends in methane and black carbon emissions (kt/a) in Finland in the period 1990–2017 per emission source.

3.2 The development and current status of air quality

Compared to many European cities, air pollutant concentrations are low in Finland. The concentrations have primarily declined so much in the period 1990–2016 that the threshold values for air quality are either not, or only seldom, exceeded. Nevertheless, air pollutants cause adverse effects on both health and the environment. Most of the pollutants that end up in Finland are long-range transboundary air pollution.

Restricting sulphur dioxide, which causes acidification, was already started in European cooperation in the 1980s, at which point the emissions and concentrations took a steep decline. This decline in sulphur dioxide has been only moderate in the 2000s. Locally elevated sulphur dioxide concentrations are mostly temporary and caused by industrial incidents. Similar trend is apparent in total reduced sulphur.

Nitrogen oxide concentrations have been in decline since early 1990s, although this trend has been clearly slower than that in sulphur dioxide concentrations. The status is the worst in street canyons with heavy traffic in Helsinki, in which the annual limit value set for nitrogen dioxide for health protection purposes has been overstepped in the period 2010–2015 based on official air quality measurements, but after 2015 only in indicative measurements. The emission restrictions for petrol engines have also clearly reduced the carbon monoxide and hydrocarbon concentrations in traffic environments.

Efforts to reduce street dust have been less successful than cutting down the direct transport-related exhaust gas emissions. Street dust particularly emerges as an increase in the respirable particle (PM_{10}) concentrations, especially in the spring. Municipalities combat street dust by cleaning streets and roads, and through dust binding efforts. As a result, the annual concentrations of respirable particles have slightly declined from the peak level of the 1990s. Dust prevention measures have also succeeded in significantly reducing the number of exceedances of the daily PM_{10} concentration limit value, for instance, in the Helsinki metropolitan area. The limit values for respirable particles have not been exceeded in Finland since 2006.

Fine particulate matter ($PM_{2.5}$) measurements were included in air quality monitoring programmes around ten years ago, i.e. before explicit requirement by EU legislation (Ambient Air Quality Directive). In Finland, $PM_{2.5}$ concentration levels determined at each measuring site (43 stations in 2016) are less than half of the limit value determined for health protection, and the concentrations have slightly declined. Fine particulate matter ends up in the air directly from emission sources or form in the air from gaseous substances. Significant volumes of direct emissions or particulate matter that rapidly solidifies in ambient air particularly often emerges in small-scale burning of wood and

other solid fuel. Similarly, traffic and street dust can act as significant causes of fine particulate matter emissions.

Most of the fine particulate matter in ambient air results from long-range transboundary air pollution or are so-called secondary particles that have formed of gases in atmospheric processes (sulphates, ammonia, organic compounds etc.). The particulate matter that has formed in this way characteristically remains in the air for long periods, and may form slowly, as a result of which the effects are often visible far away from the emission source. Based on estimates, on average 20% of the concentrations of $PM_{2.5}$ originates from domestic sources, including primary and secondary particles.[35] However, a significant share of the domestic emissions emerges in regions which also have high population density, which means that the emissions will have a considerable effect on population exposure. Examples of this include nitrogen dioxide and respirable particles in traffic environments as well as fine particulate matter, benzo(a)pyrene and black carbon in areas with low density housing that use a lot of firewood.

There have been no clear changes to ozone concentrations. Ozone is a long-range transboundary air pollutant with typically highest concentrations in urban background areas and rural areas. Although the numerical value (120 µg/m^3) determined for the long-term target for ozone for the purpose of preventing adverse health effects is annually exceeded in Finland, the number of days when the limit is exceeded has remained under 25. Therefore, the target value set for 2010 has not been exceeded.

The overall improvement of air quality has resulted in reduced exposure to many toxic organic and inorganic substances among population, particularly in cities and urban areas with industry, and this has probably brought significant public health benefits to the population of Finland.

The development of air quality in the measurement stations of certain cities and towns is presented in Figures 4–9.

35 EMEP Status Report 1/2016

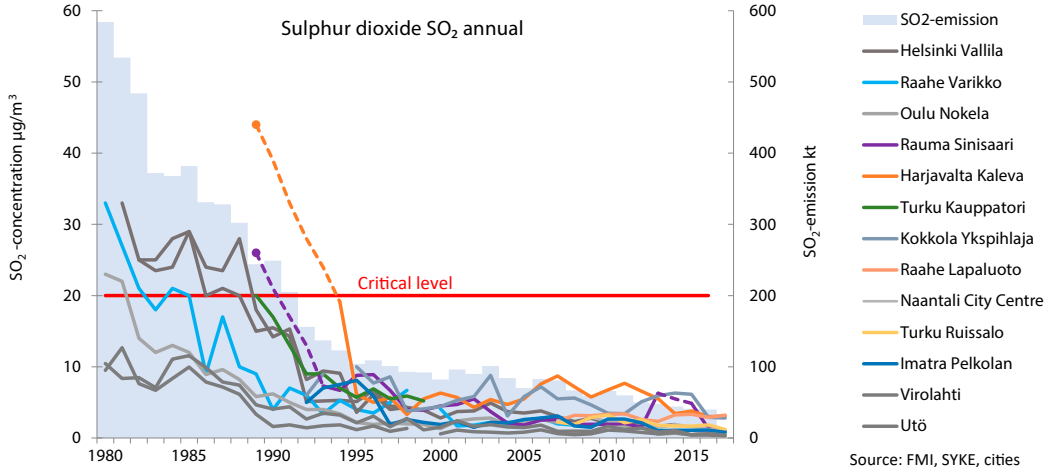


Figure 4. **Sulphur dioxide concentrations (annual averages, µg/m³) at the air quality measurement stations in certain cities and towns and total sulphur dioxide emissions in Finland (kt), 1980–2017.**

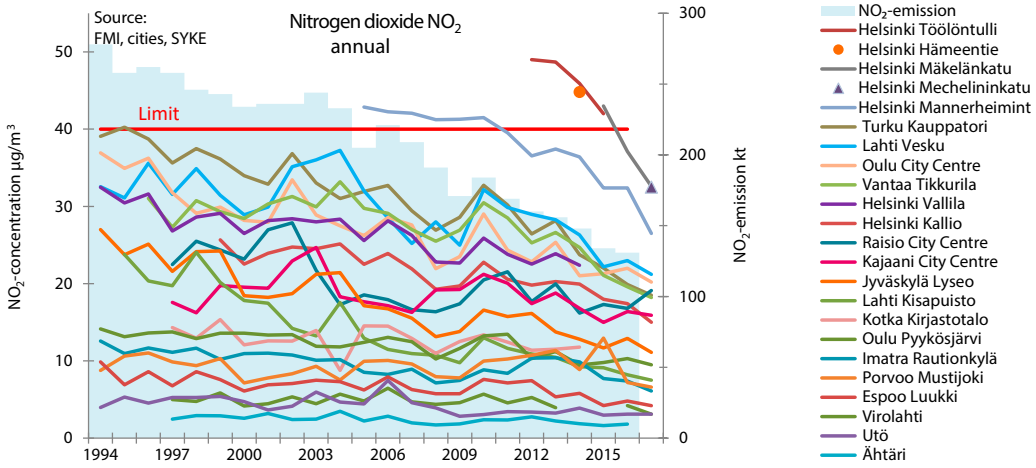


Figure 5. **Nitrogen dioxide concentrations (annual averages, µg/m³) at the air quality measurement stations in certain cities and towns and total nitrogen dioxide emissions in Finland (kt), 1994–2017.**

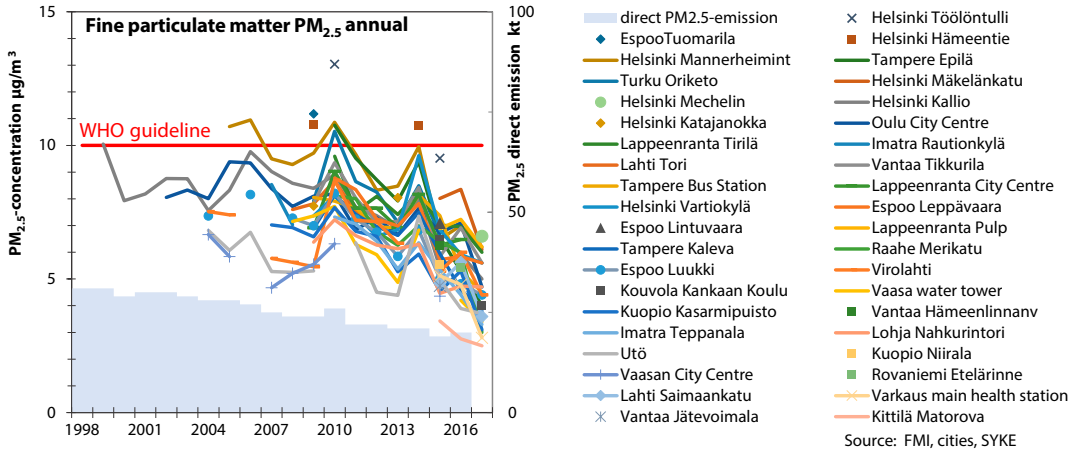


Figure 6. Fine particulate matter concentrations (annual averages, µg/m³) at the air quality measurement stations in certain cities and towns and total fine particulate matter emissions in Finland (kt), 1998–2017.

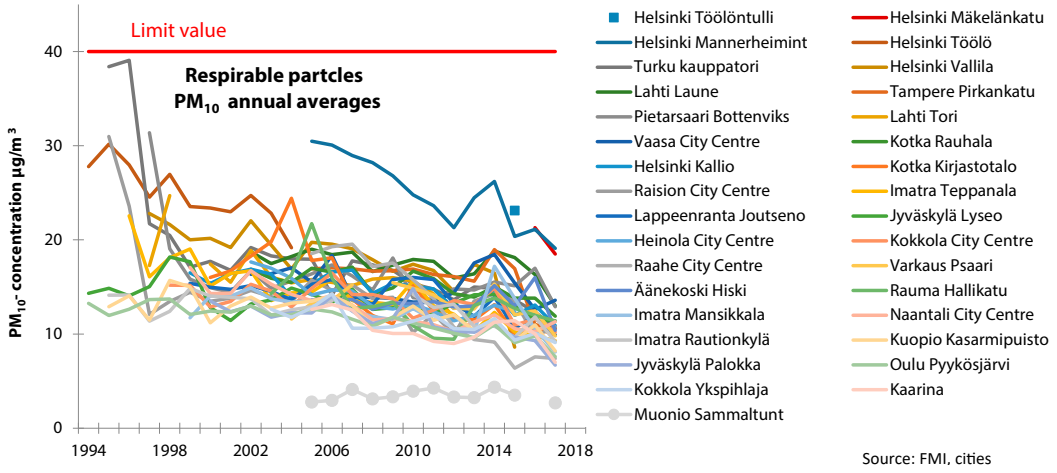


Figure 7. Respirable particle concentrations (annual averages, µg/m³) at the air quality measurement stations in certain cities and towns, 1994–2017.

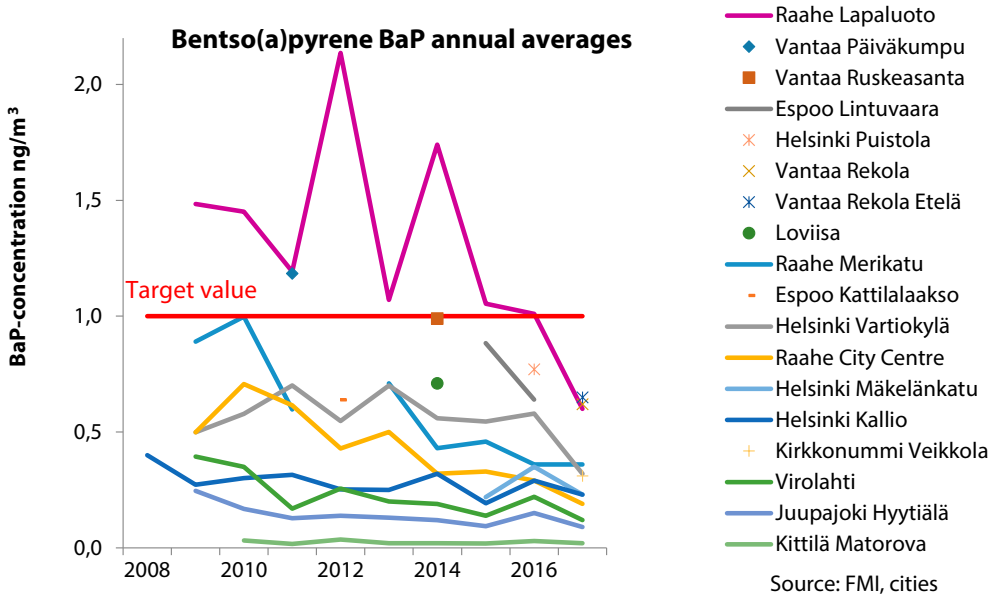


Figure 8. **Benzo(a)pyrene concentrations (annual averages, ng/ 3) at the air quality measurement stations in certain cities and towns, 2008–2017.**

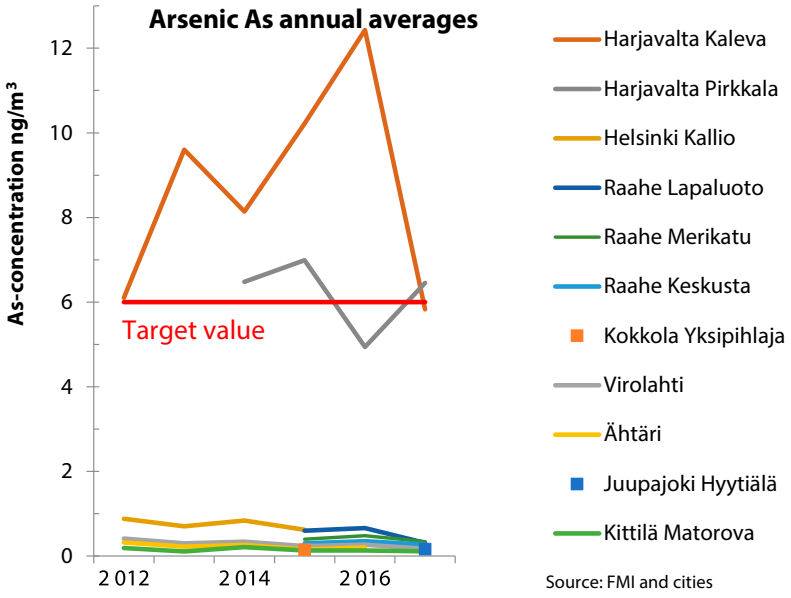


Figure 9. **Arsenic concentrations (annual averages, ng/m³) at the air quality measurement stations in certain cities and towns, 2007–2017.**

3.3 Health impacts caused by air pollutants

In recent decades, all common gas and particulate pollutant emissions have declined considerably, which has directly reflected on their concentrations in the ambient air of cities and urban areas with industry.

The majority (64%) of the adverse health effects of air pollutants are caused by fine particulate matter ($PM_{2.5}$), which contains carcinogenic compounds and heavy metals, for instance. 13% of the adverse effects are caused by respirable particulates (PM) and 13% by nitrogen oxides (NO).[36] Fine particulate matter is transported via air to all parts of the respiratory system and causes direct allergic, immunological and toxic effects on the lungs, and is also partly absorbed in the blood circulation and further carried to other parts of the body, such as the myocardium and the brain. Through oxidative stress and systemic infective effects, particulate matter increases diseases of the cardiovascular system, adding to mortality. While the effects caused by other air pollutants are also severe, they are less significant compared to those caused by fine particulate matter.

Figure 10 presents the shares of different air pollutants in causing adverse health effects in Finland in 2013. The assessment applied the disease burden approach. Disease burden describes population health loss. It combines life years lost due to premature death and morbidity rates.

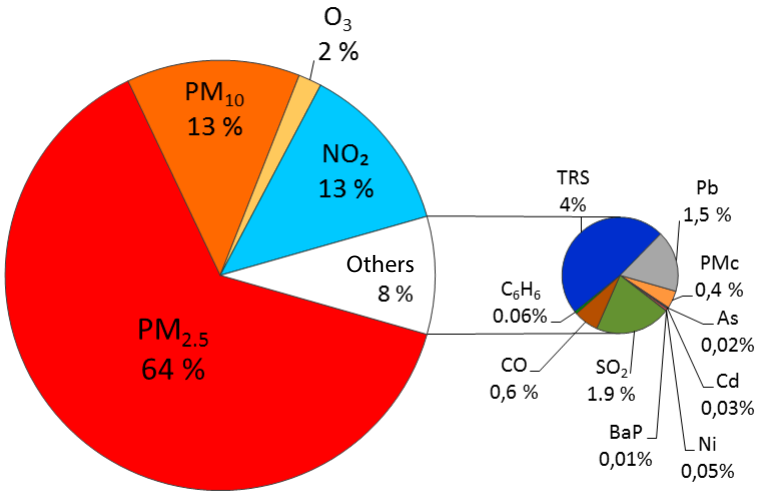


Figure 10. Burden of disease caused by air pollutants in Finland in 2013 divided based on different air pollutants. TRS= total reduced sulphur, C6H6=benzene, PMc = coarse particulate matter (Ministry of the Environment 2016).

36 The health impacts of air pollutants YMra_16_2016

While the status of air quality has considerably improved in Finland in recent years, adverse health effects continue to occur also at Finland's concentration levels.

3.3.1 Adverse health effects caused by fine particulate matter

The mass concentrations of fine particulate matter ($PM_{2.5}$) have been in a steady decline in recent decades. Cities in Finland and other EU countries only started systematically measuring $PM_{2.5}$ concentrations at the beginning of the 2000s. The decline in the concentrations is largely a result of extensive technological improvements that have been implemented and continue to be carried out in industrial and energy production plants as well as in road transport.

The adverse health effects caused by fine particulate matter are currently considered the most significant harm caused by air pollutants. It has not been possible to determine an absolute threshold level safe for human health for the fine particulate matter concentration in municipal air. Numerous studies have noted that even low fine particulate matter concentrations are hazardous for health, and that restricting exposure to fine particulate matter is beneficial for health, even when concentrations are low. The risk for adverse health effects emerging in both short-term and long-term increase as $PM_{2.5}$ concentration rises.

Scientific research from the past decades has indicated that particularly long-term exposure to $PM_{2.5}$ particles causes harm to human cardiovascular and respiratory system health (Janssen et al. 2012; WHO-REVIHAAP 2013; Chafe et al. 2015). While research has succeeded best at indicating an elevated risk for chronic bronchitis, the entry of fine particulate matter in the distal part of lungs and the constant, low-grade inflammation caused by the particulate matter here and in the circulatory system are likely to increase the risk for diseases such as coronary insufficiency and disorders of the cerebral circulation. According to assessment by the WHO, long-term exposure to fine particulate matter (between years and decades) also increases the risk for lung cancer (WHO/IARC 2016). Low-grade inflammation also appears to be linked to the onset of several other chronic diseases.

Due to unreliable research settings and register data compared to the aforementioned studies, there are far fewer studies on increasing symptoms and common pulmonary infections, doctor's appointments in outpatient care, medicine use, and absences of adults and children from work, school or childcare related to exposure to particulate matter. This has led to underestimating many less severe health impacts, while premature deaths and the resulting years of potential life lost have usually taken the main role in the adverse health effect assessments.

Short-term exposure to fine particulate matter can also cause adverse health effects. In people with respiratory diseases, such as asthma and chronic obstructive pulmonary disease patients, elevated $PM_{2.5}$ concentrations increase symptoms and often lead to a rapid decline in the person's condition, whereas in people with cardiovascular diseases, the adverse effects typically emerge after several hours or a day since uncommonly high exposure. Many Finnish and international studies have indicated that the harm caused by $PM_{2.5}$ particles (sudden deaths, hospitalisations, changes in heart and lung functions) is already visible with low concentrations measured in urban ambient air or with personal indicators.

In the atmosphere, fine particulate matter originating from the fuel consumption in low local sources will quickly grow into concentrated particulate matter of 0,1–1 µm in size. These particles can effectively penetrate residential housing and other buildings, such as schools and daycare centres, and will float in the buildings' indoor air for hours before setting down on surfaces. Therefore, these particles will remain much longer in indoor spaces and are more prone to be inhaled compared to larger and heavier particulate pollutants. In fact, a moderate share of the total exposure to, for example, chemical substances detrimental to health carried by black carbon, can occur in people's homes where most people spend the majority of their time each week and year. This, more substantial, total exposure increases the risk for illness in vulnerable population groups or may cause a flare-up of a chronic disease.

3.3.2 Estimates of the scale of adverse health effects

Advanced methods for assessing the premature mortality associated with exposure to air pollution have only been available to researchers for around ten years. The EU's second Clean Air for Europe programme (CAFE 2013) used the health research summaries compiled by the World Health Organisation (WHO) as the basis for concluding that long-term exposure to $PM_{2.5}$ particles caused around 380,000 premature deaths in the EU-27 countries in 2010. Most of the deaths were caused by cardiovascular and respiratory illnesses. In addition, the worst gaseous pollutant, ozone, caused 26,000 sudden deaths. The premature deaths caused by long-term exposure to fine particulate matter were assessed to have reduced the lifetime of vulnerable, chronically ill persons by around ten years. The direct costs and indirect financial losses caused by the premature deaths and increased morbidity in the EU-27 countries in 2010 were estimated to total at EUR 330–940 billion.

Independent studies applying different exposure assessment methods have estimated relatively consistently that 1,600–2,000 premature deaths have been caused by fine particulate matter in Finland in the period 2005–2015. Slightly under 100 acute deaths have been caused by ozone according to estimates.

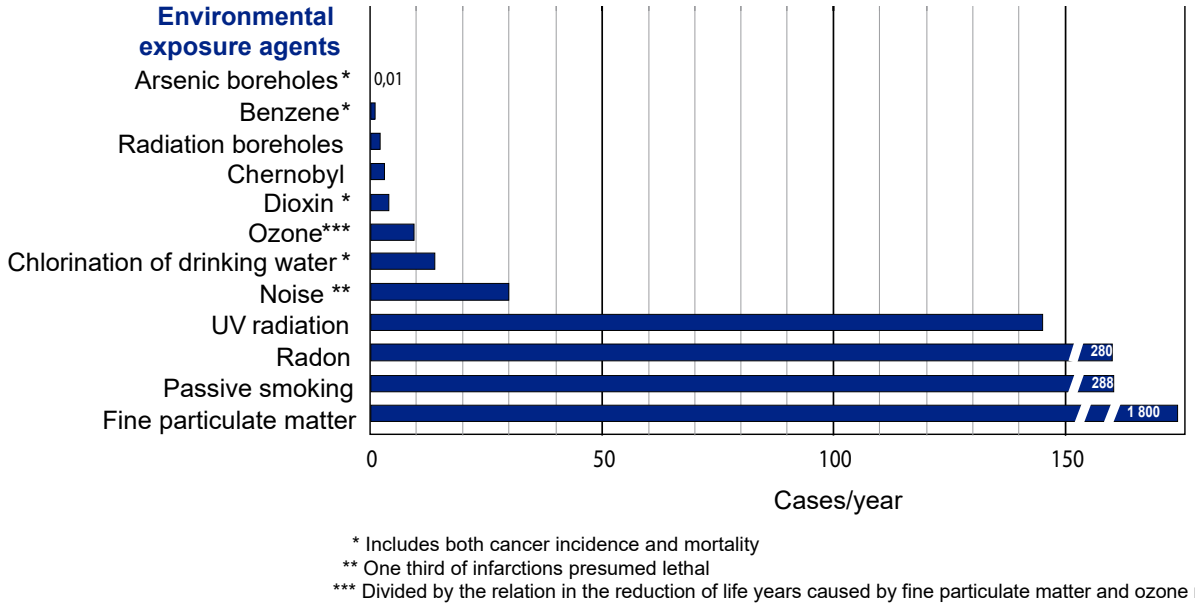


Figure 11. An assessment of the premature deaths caused by adverse environmental factors in Finland in 2005 (Hänninen et al. 2010).

An assessment carried out in Finland on the status of 2005 noted that the long-term exposure of the country's population to $PM_{2.5}$ concentration in ambient air caused a larger number of premature deaths (1,800 cases) than all other common environmental factors together (Hänninen et al. 2010) (Figure 11).

Based on an EU assessment (CAFE 2013), the annual financial losses caused by premature deaths and increased morbidity amounted to around EUR 2.3–5.3 billion in Finland in 2010.

3.3.3 Prospects by the year 2030

An assessment has been prepared of the impacts of the national energy and climate strategy and the EU's air pollution control policy on the disease burden and premature deaths caused by fine particulate matter (Karvosenoja et al. 2017). Premature deaths would be reduced by some 20% from 2015 to 2030 if the population would remain unchanged. Around half of this could be attributed to a reduction in the long-range transboundary air pollution reaching Finland. Population growth and ageing as well as constant urbanisation increase the amount of harm caused by fine particulate matter. By taking the presumed changes in the population into account, there would be an around 10% reduction in premature deaths between 2015 and 2030.

In the context of domestic emission sources, a reduction in transport-related exhaust gas emissions would bring the majority of the health benefits. The adverse health

effects caused by street dust and small-scale burning of wood are estimated to remain approximately at the current level. This would make small-scale burning of wood the largest individual factor contributing to the disease burden caused by fine particulate matter, causing more than half of the $PM_{2.5}$ emissions and premature deaths originating from exposure to domestic sources in 2030.

The share of street dust of total $PM_{2.5}$ fine particulate matter emissions will be below 10% in 2030. However, only around 10% of street dust particles are $PM_{2.5}$ fine particulate matter; coarse respirable particle (larger than 2,5 µm, but smaller than 10 µm) emissions are considerably higher. The share of street dust of respirable particle (PM_{10}) emissions is around one third of Finland's total emissions. Coarse respirable particles also causes severe adverse health effects, particularly for people with respiratory illness and asthma, and is also a source for discomfort during the street dust season.

The report has not calculated the potentially significant health impacts of secondary particles originating from domestic emissions. On the other hand, the health detriments caused by these are presumed to decline in the future as the volume of particle-forming gaseous emissions is reduced.

3.4 Environmental impacts caused by air pollutants

A value known as critical load has been determined for assessing the adverse effects of emissions causing acidification, eutrophication and the formation of low atmospheric ozone. This refers to a level of deposition or concentration of harmful substances below which emissions should be kept as part of emission reduction efforts. Critical load is determined at a level that does not cause significant harmful impacts on vulnerable parts of the environment in the long term based on current knowledge.

Acidification

The acidification of the environment refers to a decline in the capacity of soil or water bodies to neutralise the acidic deposition from the air. As acidification progresses, the acid neutralisation capacity, or buffering capacity against acidity, wears out and the pH value drops permanently below five. The reduced pH of the soil debilitates the availability of alkaline nutrients to plants, and increases the transformation of aluminium and heavy metals into toxic soluble form. Soluble metals, particularly aluminium, together with low pH cause damage to water species due to acute or chronic toxic effects, and reduce biodiversity as species vulnerable to acidity disappear.

The most significant acidifying compounds include sulphur dioxide, nitrogen oxides, and ammonia. These emissions may travel for hundreds, even thousands of kilometres in the atmosphere. According to calculations modelled for the year 2014, domestic emissions amount to 14% of the deposition of acidified sulphur compounds in Finland (EMEP 2016). According to the modelling, in 2014, 18% of the acidified nitrogen compounds and 38% of the reduced nitrogen compounds originated from domestic emissions (EMEP 2016).

Acidifying compounds fall on the ground with the rain as wet acid deposition or with particles and gases as dry deposition. Recent years have seen a considerable decline in Europe's sulphur dioxide, nitrogen oxide and ammonia emissions.

In Finland, the surface area of territories vulnerable to acidification is estimated to amount to less than one per cent of the total ecosystem surface area (Table 8). This estimate is based on an assessment of vulnerability to acidification of a representative group of lakes (total surface area 287 km2) (Hettelingh et al. 2017).

Eutrophication

Eutrophication refers to an increase in primary production resulting from the excessive nutrient availability to plants and algae. Nitrogen deposition, whose extent is affected by air emission of nitrogen oxides and reduced nitrogen compounds (incl. ammonia), causes eutrophication in soil and water ecosystems.

The assessment of eutrophication is based on the empirical limit values for nitrogen, which are 3–5 kg N/ ha/v for the majority of our ecosystems (Holmberg et al. 2011, 2017). In Finland, the critical level for eutrophication is estimated to be exceeded in only 3% of the surface area of ecosystems in 2020. The exceedances have been calculated for the biotopes located in the Natura 2000 area as well as lakes and other biotopes with a total surface area of 41,000 km2 (Hettelingh et al. 2017). Despite the fact that the nitrogen deposition causing eutrophication has declined in the entire EU territory as well as in Finland (Table 8), it continues to exceed the critical deposition level in parts of southern and western Finland (Hettelingh et al. 2017a) (Table 8, Figures 12 and 13). Nitrogen deposition may also threaten biodiversity (Table 8, Figure 14).

Table 8. The shares of areas exceeding critical load (% of ecosystem surface area) in Finland and EU-28 countries in 2005 and 2020 (Hettelingh et al.2017)

	2005		2020	
	Finland	EU-28	Finland	EU-28
Acidification	1	14	0	6
Eutrophication	10	81	1	71
Biodiversity	9	28	4	10

Ozone formation

In Finland, there is no unambiguously increasing or decreasing trend in the ozone concentration in the lower atmosphere. When the measurements began in the 1990s, the concentrations initially surged, were at the highest level at the turn of the century, and then took a slight downward turn in the 2010s. Levels critical to vegetation were not exceeded in Finland in 2014 (EEA 2017). However, the long-term target set for protecting vegetation (6,000 µg/m^3 h) is frequently exceeded in the background stations in Southern Finland.

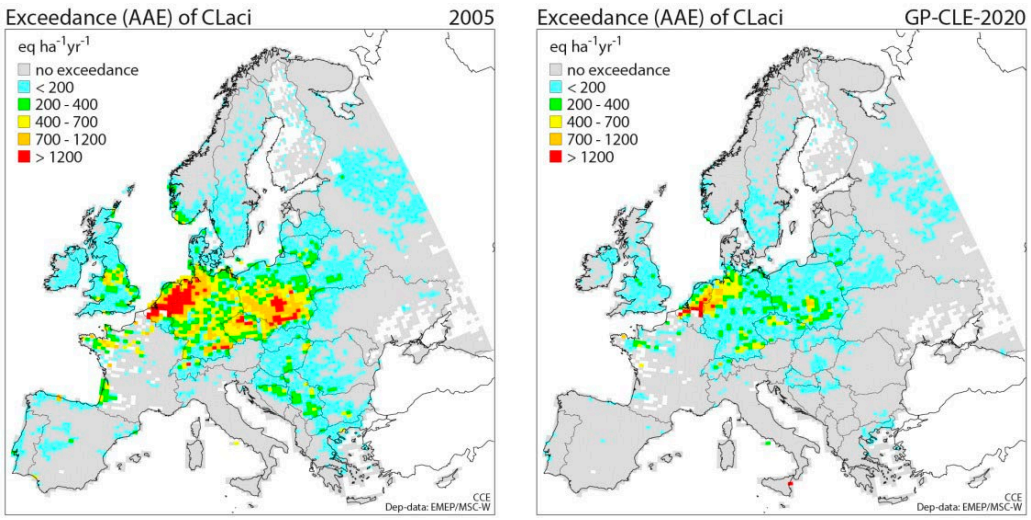


Figure 12. Total surface area of ecosystems vulnerable to acidification in Europe, 2005 and 2020 (Hettelingh et al. 2017).

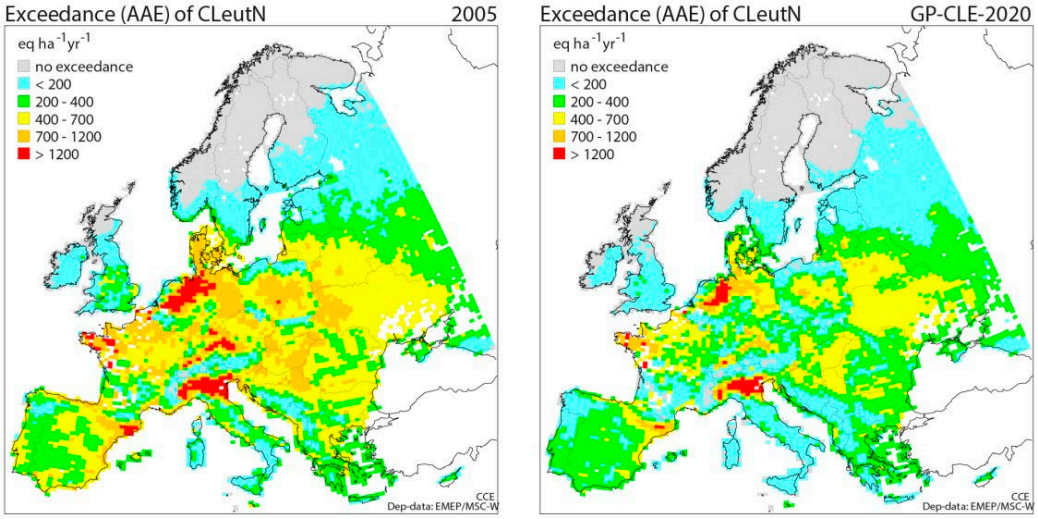


Figure 13. Total surface area of ecosystems vulnerable to eutrophication in Europe, 2005 and 2020 (Hettelingh et al. 2017).

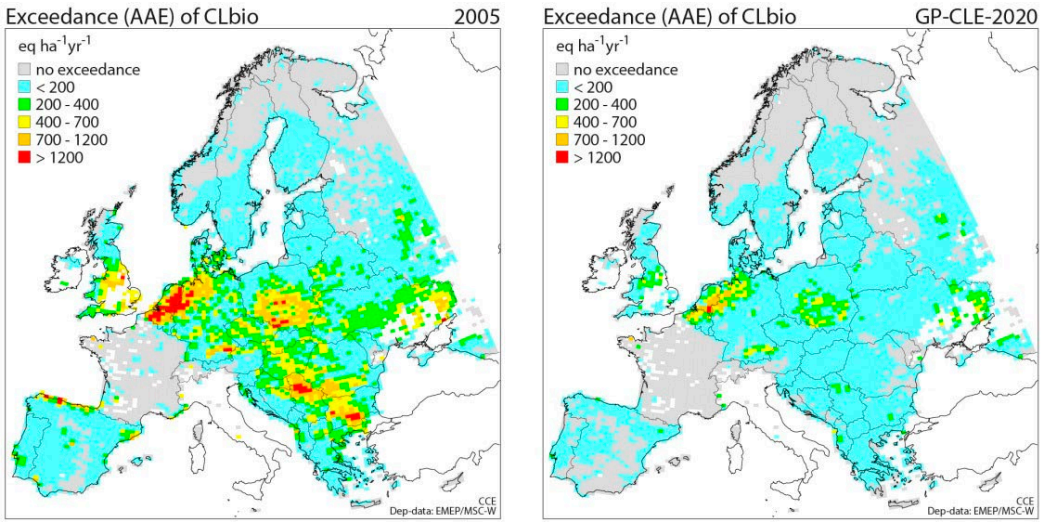


Figure 14. Exceedance of critical deposition in Europe, 2005 and 2020, assessed based on decline in biodiversity (Hettelingh at al. 2017)

4 Compliance with emission reduction and air quality commitments

Finland has been primarily reducing its emissions at least in accordance with its obligations under EU directives and national legislation. Only ammonia emissions exceeded the commitments in the period 2010–2016. While air quality is also generally good and air pollutant concentrations low in Finland, the air quality thresholds have been exceeded in some cases as mentioned above in section 3.2.

4.1 Exceedance of emission reduction commitments

According to the EU's first National Emission Ceilings Directive (2001/81/EC), Finland's annual ammonia emissions should have not exceeded 31 kilotonnes since 2010. In the period 1990–2015, Finland has exceeded this emission reduction target every year (Table 9). In 2018, Finland's atmospheric ammonia emissions were calculated using a new, revised method, and as a result, the country's ammonia emissions have complied with the commitments since 2016.

Table 9. Total ammonia emissions and the share of agriculture of these, 1990, 2005 and 2010–2016.

Year	Total emissions (kt)	Agriculture (kt)
1990	33,0	31,1
2005	37,3	31,7
2010	34,9	31,0
2011	33,8	30,3
2012	33,3	29,9
2013	32,7	29,5
2014	33,1	29,8
2015	31,4	28,5
2016	31,0	28,1

4.2 Exceedance of air quality obligations

The annual limit value set for nitrogen dioxide and daily limit value set for respirable particles have been randomly exceeded in the largest cities and in the proximity of streets with heavy traffic.[37] The lead, carbon monoxide, benzene and sulphur dioxide concentrations in Finland fall clearly below the threshold values set in the Ambient Air Quality Directive. The hourly concentrations of nitrogen dioxide and the annual concentrations of fine particulate matter fall below the threshold values everywhere in Finland.

Annual limit value for nitrogen dioxide

In Finland, the annual limit value for nitrogen dioxide harmful for human health, 40 µg/m^3, has only been exceeded in Helsinki. Since 2005, exceedances have been detected in isolated measurement stations. The binding annual limit value for nitrogen dioxide has been valid in the EU since 2010. The European Commission granted the city of Helsinki a time extension for compliance with the nitrogen dioxide limit value until the start of 2015 based on the Ambient Air Quality Directive.

According to national legislation, when the limit value is exceeded or there is a risk of this occurring, the municipality shall prepare a plan in accordance with the Environmental Protection Act for keeping pollution below the limit value. This was the basis for air quality protection plans prepared by the municipalities in the Helsinki metropolitan area to reduce air pollutant concentrations and improve air quality for the period 2008–2016. However, the measures included in the plan were insufficient, leading to further exceeding the limit value in Helsinki in 2015. As a result, the city of Helsinki prepared another air quality protection plan for 2017–2024.[38]

In 2016 and 2017, the limit value has not been exceeded in measurement stations used in the official monitoring of the threshold values. However, nitrogen dioxide is also monitored using methods more affordable than the measurement stations. These methods do not fulfil the quality requirements set to official monitoring measurements, but nonetheless enable getting a more comprehensive picture of air quality. The methods include the so-called passive collector method and new sensor techniques. The results of these measurements indicate that there is reason to continue following the city's new air quality protection plan.[39]

37 http://www.ymparisto.fi/fi-FI/Ilmasto_ja_ilma/Ilmansuojelu/Ilmansuojelun_raja_ja_ohjearvot

38 https://www.hel.fi/helsinki/fi/asuminen-ja-ymparisto/ymparistonsuojelu/ohjelmat/ilman

39 https://www.hsy.fi/fi/asukkaalle/ilmanlaatu/Sivut/ilmanlaatukartta.aspx

Road transport has the biggest impact on the high annual concentrations of nitrogen dioxide in urban environments. At the level of national legislation, emissions and concentrations are influenced by restricting the exhaust gas emissions from road transport in accordance with the EU's vehicle legislation.

Nitrogen dioxide concentrations can be reduced by affecting transport, enhancing transport system planning, and designing housing, services and workplaces as effectively as possible, promoting low-emission public transport (incl. metro and electric buses), pedestrian traffic and cycling, and by aiming to reduce private car use in city centres.

Key measures of the new air quality protection plan of the city of Helsinki include introducing low and zero emission bus fleet, increasing the share of alternative power sources in the city's own fleet and that of its contractors, expanding the charging network for electric cars, and planning transport and land use comprehensively.

Daily limit value of respirable particles

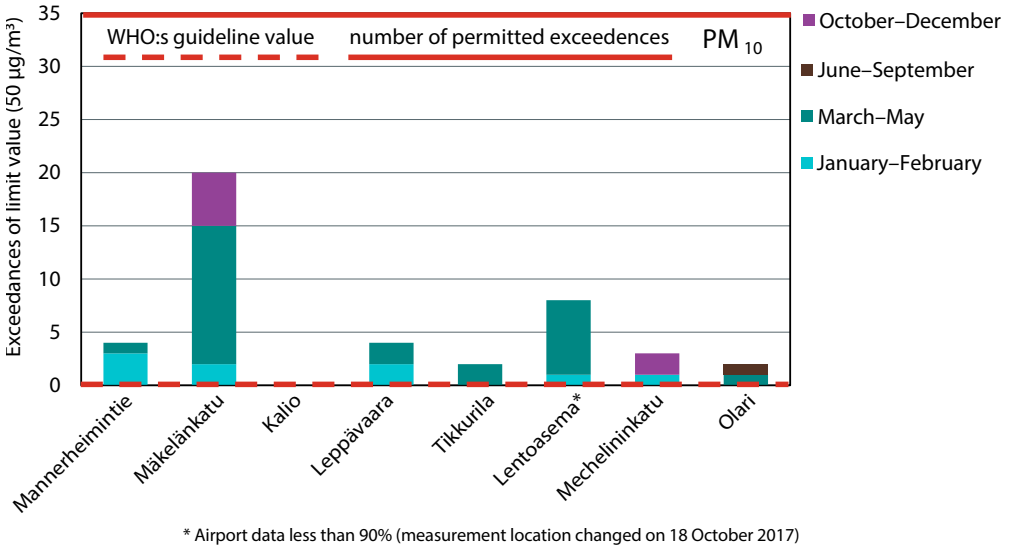
The daily limit value of respirable particles, 50 µg/m^3, may be exceeded at most 35 days per year; in Finland, this has only occurred in Helsinki. The binding limit value has been valid since 2005.

The daily limit value for particulate matter has been exceeded in Helsinki in 2003, 2005 and 2006. As a result of exceeding the limit in 2003, a report was prepared in accordance with the Environmental Protection Act, notifying that the exceedances had been primarily caused by sanding used for preventing slipperiness, assessing the areas where the limit value had been exceeded, and providing information about the measures taken by the city in an effort to reduce the concentrations. The European Commission accepted the report at the beginning of 2006. Similar reports have also been prepared for the exceedances of 2005 and 2006.

According to national legislation, when the limit value is exceeded or there is a risk of this occurring, the municipality shall prepare a plan in accordance with the Environmental Protection Act for keeping pollution below the limit value. In an area where the limit values are exceeded due to sanding or salting for the winter maintenance of roads and streets, the municipality may prepare, instead of an air quality protection plan, a report on the exceedance of the limit values, the reasons for the exceedance, and the measures required to lower concentrations. Even though the daily limit values set for PM_{10} have not been exceeded in the Helsinki metropolitan area since 2006, combating street dust has been included in the area's action programmes for the purpose of reducing concentrations and improving air quality for the period 2008–2016 as well as in the city of Helsinki's air quality protection plan for the period 2017–2024.

Exceedance of the numerical daily limit value set for PM_{10} is detected in Finland's cities, the majority of them occurring in traffic environments during winters and springs (Figure 15). The main reason for the high concentrations detected in the spring is the particulate load caused by the use of studded tyres and sanding in the previous winter. Studded tyres cause wear to the asphalt from the beginning of the studded tyre season (early November), and the sanding material also increases the volume of dust as it is pulverised under tyres, at the same time wearing down the pavement as a result of a phenomenon known as the sandpaper effect. The material may also contain dust from the start. Under humid conditions, the dust is accumulated on street surfaces and will only rise into the air during the dry seasons.

Once the number of the days of exceedance is close to 35, it can be estimated that a lower amount of studded tyres or omitting sanding during the winter could keep the critical number of days of exceedance below 35. Indeed, cities such as Helsinki have managed to reduce the number of days of exceedance by improving the effectiveness of street cleaning and anti-skid measures. Water-sieved crushed stone is used for sanding in smaller amounts than previously, and the sanding is spread on focused problem areas. The spring cleaning of the streets is systematic and carried out in as timely manner as possible. The equipment used in the cleaning is also more efficient than previously (e.g. suction road sweepers) and diluted salt solution is used to bind the dust on days with highest dust concentration. Nevertheless, not all of these measures are extensively carried out in Finland, and they have not been fully successful in providing sufficient human health and comfort. So far, the efforts have only managed to solve the problem regarding the limiting values set for air quality, not the adverse effects caused by street dust on health and comfort.



* Airport data less than 90% (measurement location changed on 18 October 2017)

Figure 15. The distribution of exceedances of the numerical daily limit value of PM_{10} at the HSY measurement stations in the Helsinki metropolitan area (HSY Air Quality in the Helsinki Metropolitan Area in 2017).

Ozone

While the target values for ozone for 2010 are not exceeded in Finland, the long-term targets are overstepped, particularly in rural background stations.

To prevent adverse health effects, the highest daily eight-hour moving average for ozone should not exceed 120 µg/m^3. However, 25 exceedances per year are allowed. The limit values are exceeded every year in rural background stations. Nonetheless, the total number of exceedances has remained below 25, therefore not exceeding the target value.

The general public must be informed if the hourly ozone concentration value exceeds 180 microgrammes in a cubic metre of air. Such high concentrations are rare in Finland. Most recently, an ozone episode exceeding the information threshold was measured in May 2006 in Virolahti.

Benzo(a)pyrene and certain metals

Arsenic, cadmium, nickel and benzo(a)pyrene concentrations are usually clearly lower than the target values with the exception of certain industrial plants. Concentrations may exceed the target value in their areas of influence. Annual concentrations of benzo(a) pyrene may even be high enough to reach or even exceed the target value concentration in urban areas with a lot of small-scale burning of wood.

The annual average concentration of benzo(a)pyrene may not exceed the target value of 1 ng/m^3. The target value has been applied since 2013. It was been exceeded in Raahe in the period 2013–2016 and in the Helsinki metropolitan area (Vantaa) in 2014.

The annual average concentration of arsenic in air may not exceed the target value of 6 ng/m^3; the corresponding rate is 5 ng/m^3 for cadmium and 20 ng/m^3 for nickel. The target values have been applied since 2013. Of these, the target value for arsenic was exceeded in Harjavalta in the period 2013–2016 and for nickel in 2016.

5 The development of emissions in the baseline

This section presents the historical evolution of the emissions examined in this Air Pollution Control Programme and an emission projection for 2020, 2025 and 2030. The emission projection modelled for 2020–2030 is called a baseline. The development of emissions is affected by both technical reduction measures as well as changes in the fuel consumption, number of animals and other factors known as activities.

The activity projections in the baseline, i.e. development of fuel consumption or volume in different sectors, are primarily based on the National Energy and Climate Strategy and other sources where necessary (Table 10). The baseline scenario also pays attention to legal measures which influence emission abatement and whose implementation has already been decided on (Table 11). The measures suggested in the medium-term climate change policy plan are not included in the baseline.

Table 10. Activity projections used in the emission modelling for the baseline. The emission projection for traffic has been directly copied from the LIPASTO model.

Emission sector	Activity/emission projection
Energy production and industry	Energy and Climate Strategy, policy scenario
Small-scale burning of wood in households	Energy and Climate Strategy, baseline scenario.
Waste sector	Energy and Climate Strategy, baseline scenario
Transport and machinery	LIPASTO model by VTT
Agriculture	The NH_3 model of LUKE and SYKE

Table 11. The most significant statutes and measures affecting emission trends in the emission projection, i.e. baseline, modelled for 2020– 2030

Activity	Statute or other measure
Energy production and industry (incl. waste incineration)	• The Industrial Emissions Directive, and the BAT conclusions concerning energy production and different industrial sectors, Medium Combustion Plant Directive • Environmental Protection Act (527/2014) • Government Decree on Limiting Emissions from Large Combustion Plants (936/2014) • Government Decree on Environmental Protection Requirements for Medium-sized Energy Production Units (1065/2017) • Government Decree on Waste Incineration (151/2013)
Transport	• Euro emissions standards (Euro 1–Euro 6) • Act on Promoting Use of Biofuels in Transport (446/2007)
Agriculture	• The Industrial Emissions Directive and the BAT conclusions for the intensive rearing of poultry or pigs (Commission Implementing Decision (EU) 2017/302), Nitrates Directive • Environmental Protection Act 527/2014 • Nitrate Decree (1250/2014) • Action programme for reducing the ammonia emissions originating from agriculture in Finland. Publication by the Ministry of Agriculture and Forestry 1/2018
Small-scale burning of wood	• Ecodesign Directive (2009/125/EC) and the Commission Regulations implementing the Ecodesign Directive for solid fuel local space heaters (2015/1185) and solid fuel boilers (2015/189)
Waste sector	• Waste Act (646/2011) • Government Decree on Landfills (331/2013)

The projections for fuel consumption in energy production and industry are from the policy scenario of the national energy and climate strategy, which are better aligned with the target of Prime Minister Sipilä's Government for phasing out the use of coal by 2030 compared to the strategy's baseline scenario. While the policy scenario does not involve fully eliminating coal use, it is reduced much more radically from the current status compared to the baseline scenario. Overall, the scenarios are highly similar in terms of fuel consumption in the energy production sector. In the context of small-scale burning of wood in households, the activities are in line with the baseline scenario of the energy and climate strategy.

The projection for traffic-related fuel consumption and emissions in based on the LIPASTO model of VTT Technical Research Centre of Finland, whose calculation methods were updated in 2018. The activity projection for fuel consumption in road transport is somewhat higher than in the scenarios included in the strategy. In machinery and transport excluding road traffic, the projection corresponds well with the energy and climate strategy. The sector "machinery and other transport" also includes emissions from rail traffic, and domestic waterborne and air transport.

Emissions from industry and energy production as well as small-scale burning of wood have been calculated with the national FRES emission scenario model (Karvosenoja 2008).

Moreover, the street dust emissions caused by traffic have been assessed using the FRES model based on a national application of the NORDUST model (Kupiainen et al. 2018). Key factors for the emissions of agriculture include projections for changes in numbers of animals and manure processing, which are based on the data of the Natural Resources Institute Finland.

Agriculture-related ammonia emissions have been calculated using an emission model for agriculture (Grönroos et al. 2017). No projections have been modelled for some of the less significant emissions sectors; instead, the emissions have been kept at the level of the most recent year of inventory, 2016.

The following subsections present projections of pollutants included in the NEC Directive and discuss the key factors affecting emission trends. The development of emissions is presented at five-year intervals in that the numbers for the period 2005–2015 are from the national emissions inventory (year of reporting 2018) and the subsequent projections are modelled, relative reductions from the emissions in 2015.

The emission projection figures also present emission reduction commitments according to the NEC Directive for the pollutants for which commitments have been determined. The reduction commitments are given as relative reductions from the level of emissions in 2005. As a result, the emission volumes meeting the commitments set for 2020 and 2030 may still change if development in the calculation methods of the emissions inventory results in changes in the emission projections for 2005. According to the most recent emissions reporting, the emission reduction commitments set for 2020 were already met in 2016[40], but in case of some pollutants, emissions must be further cut from the current status to meet the commitments of 2030.

In addition to the pollutants included in the reduction commitments of the NEC Directive and the trend in black carbon and methane emissions. The estimated development in these emissions is crucial for preventing the warming of the Arctic region in the work of the Arctic Council. Black carbon emissions must also be reported in accordance with the NEC Directive.

Although respirable particles (PM_{10}) fall outside the scope of the emission reduction commitments of the NEC Directive, the Member States are required to annually report the volume of particulate matter emissions to the Commission. Therefore, the development of respirable particle emissions is not dealt with in the present section but, instead, in chapter 3.

40 Informative Inventory Report (IIR)

5.1 Sulphur dioxide

Status: If the development continues in the baseline, the emission reduction commitment for 2020 has already been accomplished, and the commitment set for 2030 will also be achieved.

The majority of Finland's sulphur dioxide emissions originate from the fuel consumption for energy in power plants and industry (Figure 16). The biggest individual emission sources are oil refinery and metal industry plants, and power plants running on coal. The emissions for 2016 were already clearly below the commitment level, and the reduction of coal consumption and application of the BAT conclusions[41] in power plants will continue to cut emissions in the future.

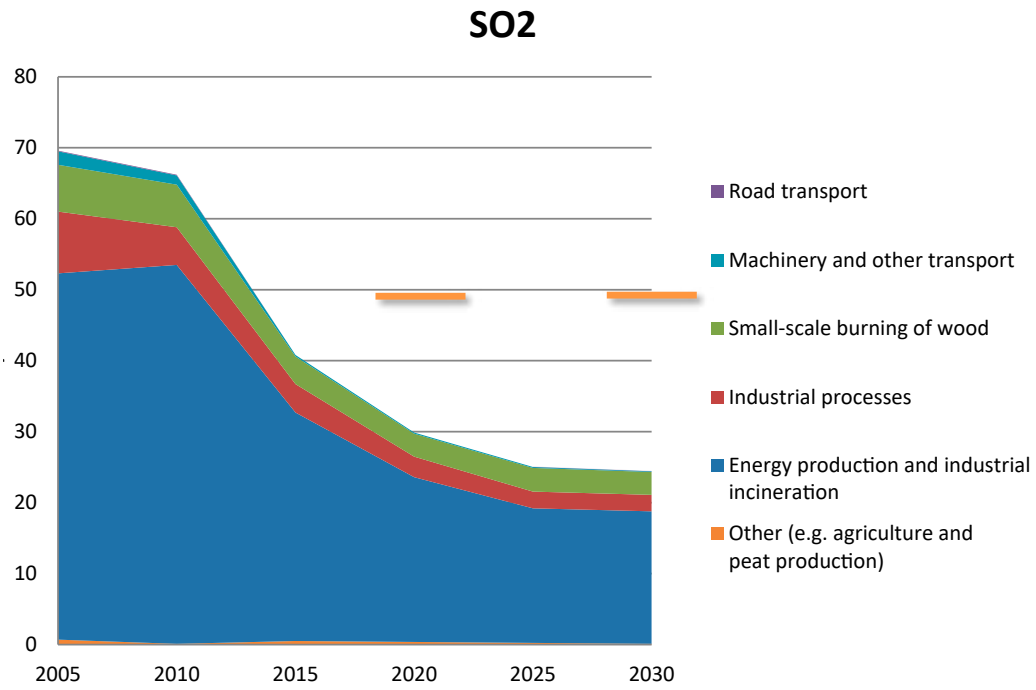


Figure 16. The development of sulphur dioxide emissions in the baseline per sector. The orange lines describe the level in accordance with the emission reduction commitments.

41 http://www.ymparisto.fi/fi-FI/Kulutus_ja_tuotanto/Paras_tekniikka_BAT/Vertailuasiakirjat

5.2 Nitrogen oxides

Status: If the development continues in the baseline, the emission reduction commitment for 2020 has already been accomplished, and the commitment set for 2030 will also be achieved.

The biggest emission sources for nitrogen oxides are road transport and mobile machinery, and energy production and industry (Figure 17). Emissions from traffic and machinery have declined and continue to drop thanks to EU legislation even though traffic volumes have been moderately increasing. Meeting the presumed emission reductions in the transport sector plays a key role in achieving the emission reduction commitments set for nitrogen oxides. In the baseline scenario, the share of alternative power sources will not increase significantly, as a result of which the development of combustion engine technology mostly affects emission reduction. The nitrogen oxide emissions have often not corresponded to the levels reported by manufacturers in normal driving, and the impact of this knowledge on the emission values of LIPASTO have been updated in 2018.

All combustion processes produce nitrogen oxide emissions. According to the national energy and climate strategy, fuel consumption in energy production will increase by over 20% from 2015 to 2030. As a result, the NOx emissions of energy production will only moderately increase in the baseline scenario despite the fact that many energy production plants are investigating and implementing emission reduction approaches based on BAT technology. In 2030, energy production and industry would cause nearly 60% of Finland's NOx emissions.

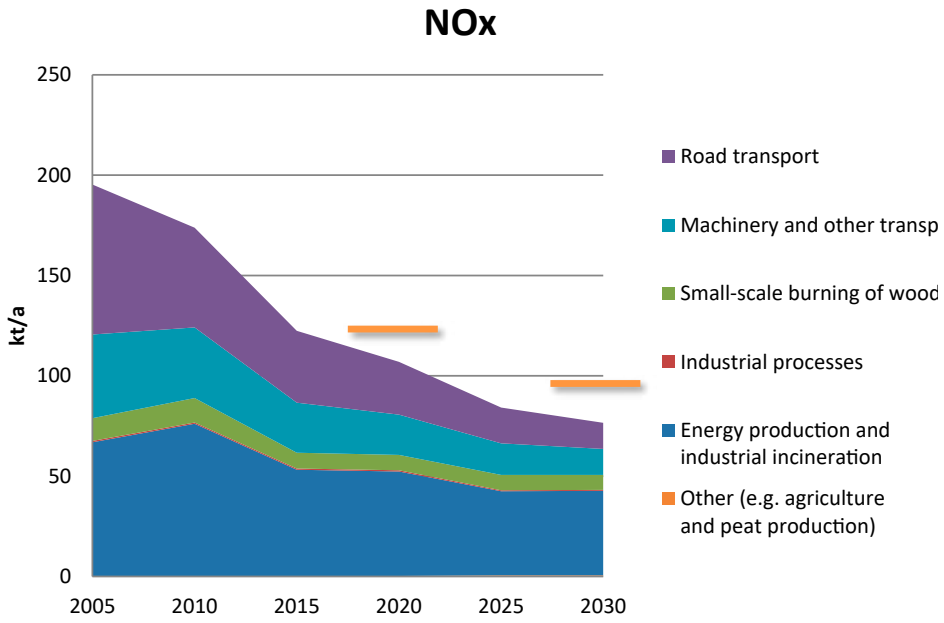


Figure 17. The development of nitrogen oxide emissions in the baseline per sector. The orange lines describe the level in accordance with the emission reduction commitments.

5.3 Fine particulate matter

Status: If the development continues in the baseline, the emission reduction commitment for 2020 has already been accomplished, and the commitment set for 2030 will also be achieved.

While fine particulate matter emissions originate from a number of sectors, small-scale burning of wood has emerged as the most significant emission source in the 2000s (Figure 18). The exhaust gas emissions from transport and machinery have declined and continue to drop as engine technology develops and fleet is updated. The exhaust gases from the transport sector will be a comparatively minor emission source by 2030. The emissions from energy production will also have declined as a result of stricter legislation and emission-cutting technology. Emission levels in accordance with the BAT conclusions will continue to drop from the current level even though fuel consumption is set to grow in the baseline scenario.

The development of engine technology in means of transport has no effect on street dust emissions. Street dust emissions include particulate matter originating from the abrasion of roads, brakes, tyres and gravel used for sanding. Cars also cause other dust that has set on the road to re-elevate to the air. The share of coarse respirable particles (PM_{10}) is high in street dust. In fact, street dust is the biggest individual emission source for PM_{10} particles. Nevertheless, the emissions also include fine particulate matter, and as exhaust gas emission emissions are reduced, the share of street dust of total traffic-related fine particulate matter emissions will become increasingly significant. The baseline scenario does not presume there to be an increase in the measures restricting street dust emissions. This means that there is a slight increase in emissions in accordance with the presumed growth in the transport performance. Trends in the dust emissions from peat production and agriculture as well as other fugitive emissions have not been modelled, but these are set to remain at the level of 2016 in the projection.

The particulate emissions of small-scale burning of wood will be restricted for the first time with legislation as the Commission regulations based on the Ecodesign Directive set maximum emission limits for new small fuel boilers and local space heaters from 2020 and 2022. The effects of the directive by 2030 will be minor, on one hand, as the equipment is renewed slowly and, on the other, as the majority of space heaters sold in Finland have already fulfilled the emission limits set in the directive for years (Savolahti et al. 2016). The directive also does not concern wood-burning ovens, which are estimated to currently cause 40% of the $PM_{2.5}$ emissions from small-scale burning of wood.

The harm caused by small-scale burning of wood is also affected by the amount of wood burned, which is evaluated at around 10-year intervals. According to statistics, the total

use of firewood and pellets was around 19 TWh in 2010 and 17 TWh in 2015. The annual temperature fluctuation considerably affects the projected wood consumption; in 2010, wood burning was highest since the 1970s due to cold winter temperatures. Firewood consumption is explored in surveys. Natural Resources Institute Finland has investigated small-scale burning of wood in four surveys carried out since 1992. The most recent survey was concerned with the heating period 2016/2017, during which wood consumption was three per cent higher compared to the previous survey conducted in the heating period 2007/2008. The wood consumption for small-scale burning has been growing clearly most considerably in the few decades before this. The moderate growth of recent times is also presumed to continue in the national energy and climate strategy. In the strategy, the consumption rates for 2030 are estimated to be in line with those of peak year 2010. However, predicting the overall trend in wood consumption is difficult, and spikes in need for heating caused by cold years may affect the achievement of emission reduction objectives.

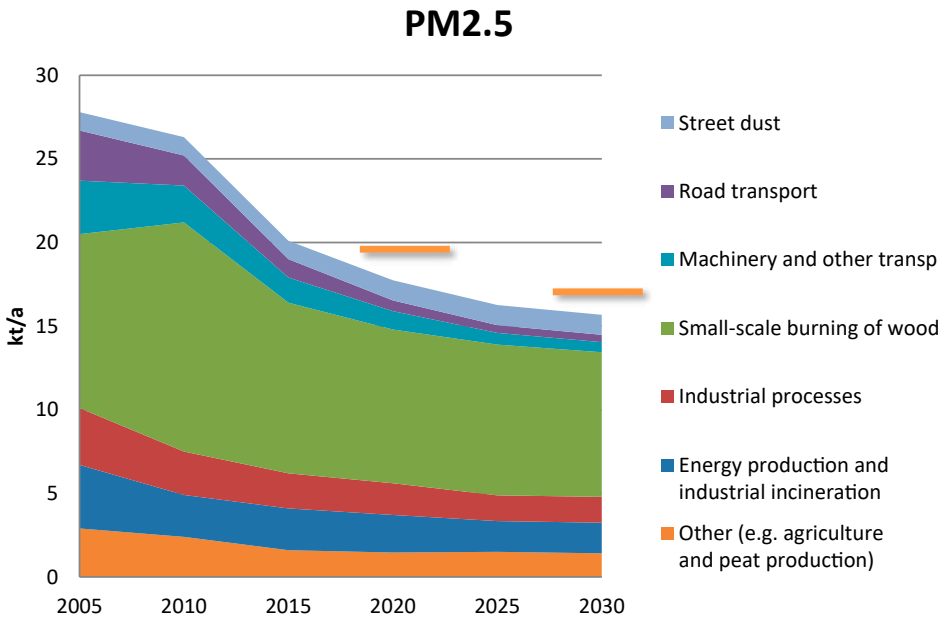


Figure 18. The development of fine particulate matter emissions in the baseline per sector. The orange lines describe the level in accordance with the emission reduction commitments.

Around 40% of the emissions from small-scale burning of wood are estimated to originate from sauna stoves (Figure 19). Sauna stoves are covered by the scope of the Ecodesign Directive, as a result of which their emission factors have not been expected to change in the future in the modelling. However, based on the most recent, currently unpublished preliminary emission measurements, it appears that the equipment presently available in the market have, on average, much lower emissions than what is presumed in the emission calculations. Making use of the most recent measurement results in the calculations is likely to reduce the emission projections, at least post-2015.

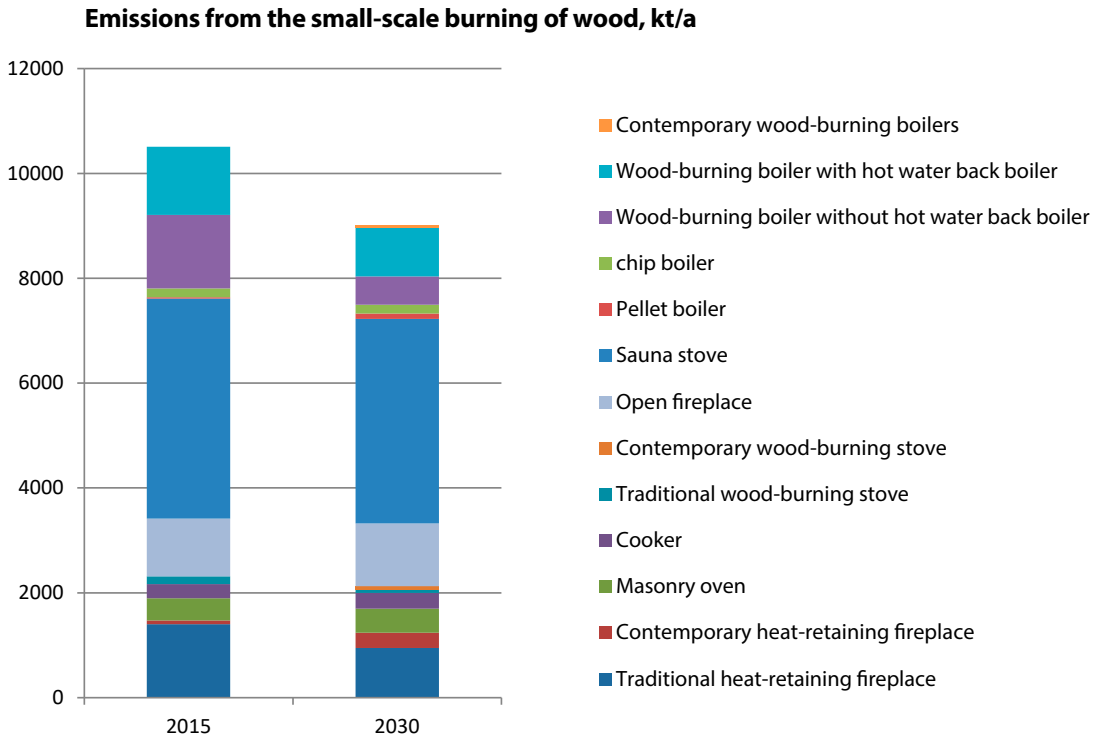


Figure 19. $PM_{2.5}$ emissions from small-scale burning of wood divided based on burning unit types. Particular attention has been paid to the combustion air input in contemporary heat-retaining fireplaces and wood-burning stoves.

Figure 20 presents modelled fine particulate matter concentrations in air in Finland in the years 2015 and 2030. The concentrations include domestic primary and secondary particles and the impact of long-range transboundary air pollution on the concentration. Long-range transboundary air pollution from Central Europe causes clearly higher background concentrations in the south of Finland compared to the northern parts of the country. The significance of local emissions on air quality is particularly emphasised in densely populated areas and by the biggest roads.

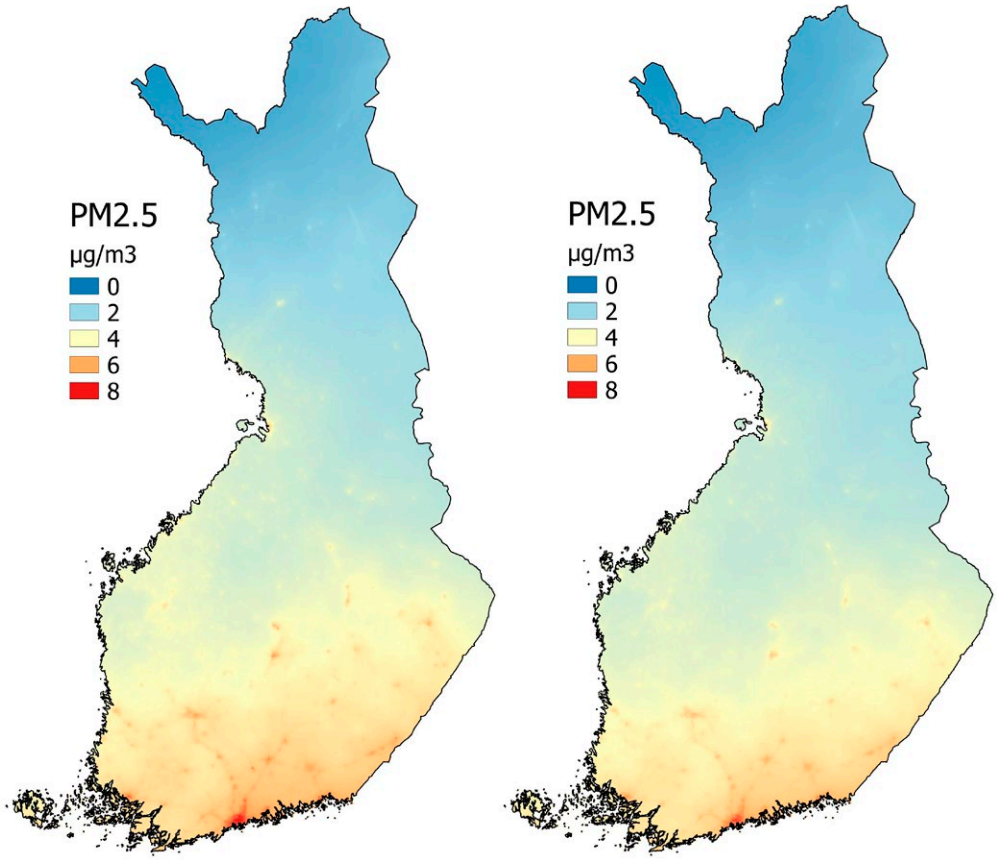


Figure 20. **Figure 20. Modelled fine particulate matter ($PM_{2.5}$) concentrations in air in 2015 and 2030. The modelling has taken all domestic emission sources and long-range transboundary air pollution into consideration. Fine particulate matter includes both primary and secondary fine particulate matter (produced in the BATMAN project using the SILAM model of the Finnish Meteorological Institute).**

5.4 Volatile organic compounds

Status: If the development continues in the baseline, the emission reduction commitment for 2020 has already been accomplished, and the commitment set for 2030 will also be achieved.

Volatile organic compound (excluding methane) emissions have declined to nearly half between 2005 and 2015, and the emission level is already close to the goal set for 2030 (Figure 21). The biggest reductions have resulted from cuts in emissions from traffic and machinery as well as industrial processes. In the future, emissions are expected to remain close to the current level in sectors other than transport and machinery, in which emissions are set to further decline as vehicle stock is renewed. The category "industrial processes" also includes industrial paint shops, which is the biggest emission source within the sector. Different process industries also cause NMVOC emissions, which are restricted with emission limits included in the BAT conclusions. However, the impact of the implementation of the BAT conclusions on emission volumes is not assessed in this section with the exception of the oil refining industry. The sector "Other" mostly includes the emissions caused by solvent use and evaporative emissions caused by, e.g. oil distribution and storage. The development in the emissions in this sector has not been modelled, but the emissions have been frozen to the level of 2016.

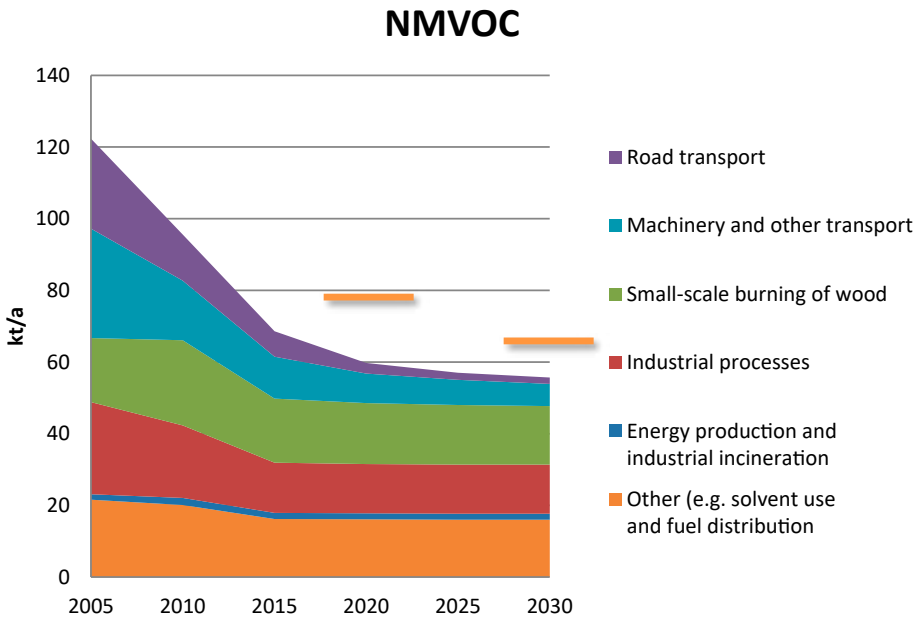


Figure 21. The development of NMVOC emissions in the baseline per sector. The orange lines describe the level in accordance with the emission reduction commitments.

5.5 Ammonia

Status: If the development continues in the baseline, the emission reduction commitment for 2020 has already been accomplished, and the commitment set for 2030 will also be achieved.

Around 90% of ammonia emissions originate from agriculture (Figure 22), particularly the processing and application of manure. Agricultural emissions have dropped in the 2000s partly due to a reduction in the number of livestock and partly as the use of emission-cutting manure processing technology has increased. In addition to these factors, emissions are influenced by the amount of nitrogen emitted by animal manure each year, which is dependent on issues such as animal material and feeding. As the productive capacity of animals has increased, the amount of nitrogen emitted per animal has also climbed, which has slowed down the decline of ammonia emissions originating from manure.

The ammonia emissions from agriculture are projected to further decline in the future, particularly as a result of the expected reduction in animal volumes. Nevertheless, measures pertaining to manure processing technology are needed, for which purpose an action programme for reducing the ammonia emissions originating from agriculture in Finland has been prepared in cooperation between the Ministry of Agriculture and Forestry and the Ministry of the Environment (Ministry of Agriculture and Forestry 2018). The development of ammonia emissions from sectors other than agriculture has not been assessed; instead, their emissions have been frozen at the level of 2016 in the projection.

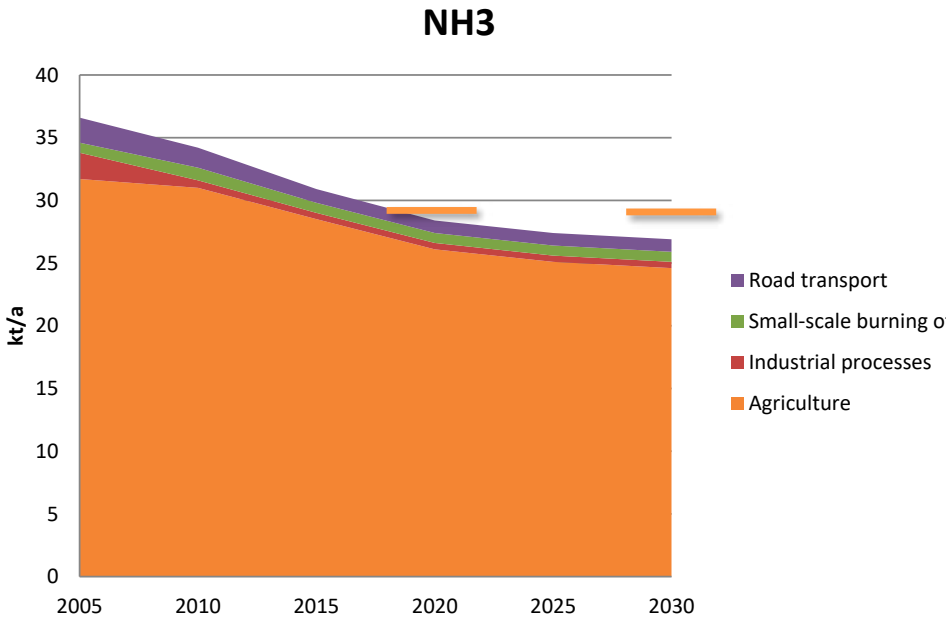


Figure 22. The development of ammonia emissions in the baseline per sector. The orange lines describe the level in accordance with the emission reduction commitments.

5.6 Black carbon and methane

The National Emission Ceilings Directive contains a reporting duty for black carbon but no related emission reduction commitment. The directive also refers to black carbon in connection with fine particulate matter, stating that the reduction measures should particularly target the emissions with high black carbon content. In Finland, black carbon mostly originates from transport and the small-scale burning of wood. By 2030, small-scale burning of wood is estimated to remain the only significant emission source for black carbon (Figure 23), as traffic emissions are reduced as a result of advancements to engine technology. The measures used to reduce the fine particulate matter emissions from small-scale burning of wood as also effective in reducing black carbon emissions. The Arctic Council set a joint voluntary goal of 25–33 per cent emissions reductions by 2025 compared to the level of emissions in 2013. The development of Finland's emissions would comply with this goal in the baseline scenario.

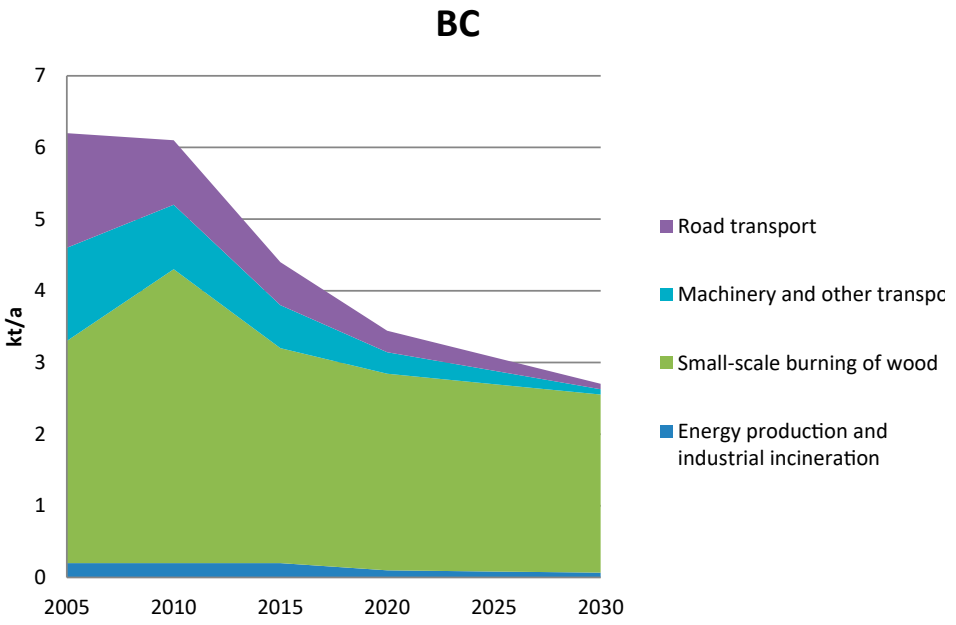


Figure 23. The development of black carbon emissions in the baseline per sector.

While methane is not one of the pollutants monitored by the NEC Directive, methane emissions are reported within the frame of the Convention on Climate Change. Methane emissions have not been separately calculated in preparing this programme; instead, the below projection is from the National Energy and Climate Strategy (Figure 24). The ban for the landfilling of organic waste, which entered into force in 2016, particularly affects the emission trend in the waste sector. However, the current landfills will continue to be sources of methane emissions. Agriculture-related methane emissions are projected to keep growing slightly until 2020, after which they will take a downward turn.

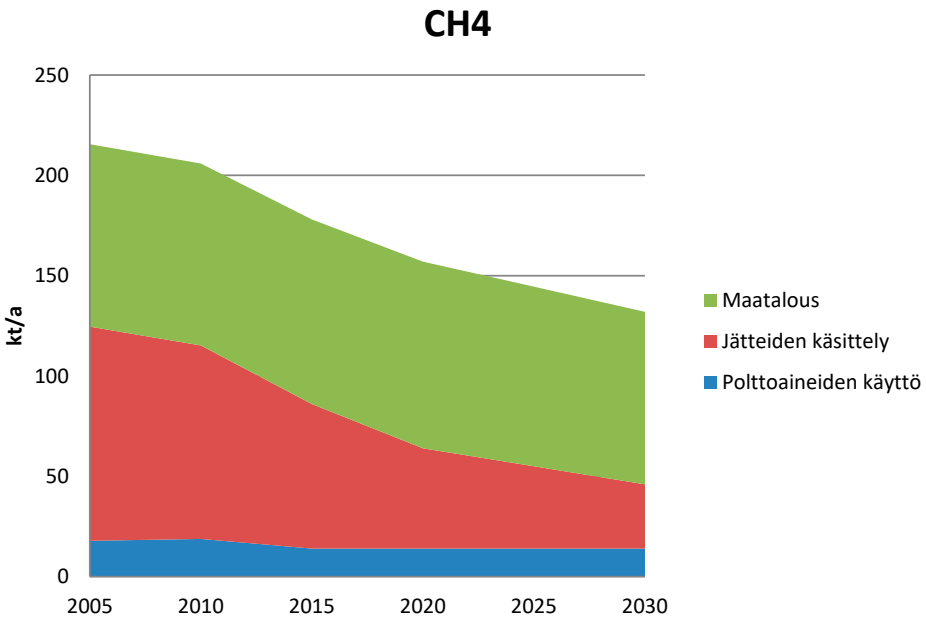


Figure 24. The development of methane emissions in the baseline per sector.

5.7 Conclusion

The emission reduction commitments set by the National Emission Ceilings Directive will be met with the baseline measures presented in this chapter. In addition, the measures planned to reduce greenhouse gas emissions (incl. the implementation of the medium-term climate change policy plan) will improve the effectiveness of the reduction of pollutant emissions.

Nevertheless, some uncertainty is associated with the assessments concerning the implementation of the emission reduction commitments. These include a failure to implement some of the measures proposed by the national energy and climate strategy and the action plan to reduce ammonia emissions from agriculture, or an unexpected growth in the activities used as the basis for the calculations, leading to an increase in the emissions differing from the projections. Similarly, constantly developing calculation methods may also change the emission rates of previous years that have already been reported on.

The implementation of the emission reduction commitments is monitored using the emission inventories and projections prepared and updated by the Finnish Environment Institute. The National Air Pollution Control Programme must be updated if monitoring indicates a failure to meet one or several emission reduction commitments or a thread of such.

6 Additional measures and their impacts on emissions and air pollutant concentrations

Air pollutants will continue to cause health and environmental hazards in 2030 (see 3.4) even if the commitments imposed by the National Emission Ceilings Directive are met. This makes it important to examine the alternative measures that can lower the air pollutant emissions and concentrations even below the level required by EU legislation.

This section presents measures for improving air quality and reducing the number of people exposed to poor air quality, particularly in areas with the highest exposure rate. Fine particulate matter emissions emerging in urban areas and close to breathing height are the air pollutant emissions most harmful to human health (Savolahti et al. 2018). They mostly originate from small-scale burning of wood and road traffic. The dust and exhaust gas emissions caused by increasing the density of urban structures with massive, long-term construction projects are also problematic. Particularly reducing the emissions from these sources can best affect air quality in densely populated areas.

Moreover, in order to ensure positive development in air quality, no decisions may be made in any of the sectors with influence on air quality that may impair air quality in the short or long term. To prevent such trends, it is vital to take air quality into account in all strategies, programmes and projects affecting air pollution control planned and implemented in different sectors of society. To ensure that air quality is developing to the right direction, measures promoting this objective are proposed.

The additional measures decided on at the national level proposed in the present section can be used to improve public health and people's wellbeing, and to reduce the costs caused by the adverse effects of air pollutants.

6.1 Road transport

The poor quality caused by transport is a result of exhaust gas emissions and street dust. Harms can be reduced by affecting the energy efficiency of transport systems, the energy efficiency of vehicles, replacing fossil, oil-based fuels with electricity and gas, and regulating local emissions. In addition to the emissions from fuel consumption, street dust causes adverse effects on health and comfort, which can be reduced by preventing street dust from forming.

The exhaust emissions from vehicles have been effectively cut through EU's legislation on different vehicles. Efforts to reduce street dust have been less successful. While the concentrations have been somewhat cut from the peak level of the 1990s, elevated respirable particle (PM_{10}) concentrations continue to cause adverse health effects on people. Municipalities combat street dust by cleaning streets and roads, and through dust binding.

In the policy scenario of the national energy and climate strategy, the fuel consumption of road transport will decline considerably more from the current level than in the baseline scenario presented in the previous section. This would also reduce air pollutant emissions. Road transport particularly plays a key role in cutting nitrogen oxide emissions. The Government Report on Medium-term Climate Change Plan present measures with which the fuel consumption of road transport could be reduced to the level of the policy scenario.[42] These include improving the efficiency of energy consumption in transport and increasing the share of electric cars. If the energy consumption of road transport would be at the level indicated in the policy scenario, NOx emissions would decline by slightly under 2 kt more than in the projection included in chapter 5 in 2030.

Tables 12a and 12b present measures for reducing the adverse health effects caused by transport-related exhaust gas emissions and street dust. The measures have been primarily presented in other policies concerning transport. However, an aim of this National Air Pollution Control Programme is to support these policies and ensure their implementation.

Table 14 also presents the connections and effects of the current strategies, programmes and projects applying to various sectors, including the transport sector, and proposes measures for taking air pollution control into consideration in the implementation of these instruments and related updates better than currently.

42 Ministry of the Environment 2017. Government Report on Medium-term Climate Change Plan for 2030 – Towards Climate-Smart Day-to-Day Living. Reports of the Ministry of the Environment 21/2017.

Table 12a. Measures for reducing air pollutant emissions caused by road transport

MEASURE	EFFECTS, COST PERSPECTIVES	PARTIES RESPONSIBLE
Supporting measures and proposals concerning accelerating the renewal of vehicle stock and increasing the share of zero and low emissions vehicles in traffic • stricter threshold values set for heavy transport, and passenger cars and vans • an act on clean vehicle procurement in the public sector • an appropriation for procuring fully electronic cars • appropriations for constructing a distribution infrastructure for alternative power sources • company cars with zero and low emissions • scrapping reward campaigns that may not even require purchasing a new car • developing traffic taxation Updating the information concerning energy labelling in cars • informing consumers of environmentally friendly vehicles	Measures reducing CO_2 emissions will also reduce local emissions. The limit values will guide car manufacturers to develop low and zero emissions cars, which will increase their numbers in the market. An act on clean vehicle procurement in the public sector will strongly influence future vehicle and transport service procurement in the public sector to make a transition to electricity, gas and other power sources. An appropriation fir fully electric vehicles (EUR 24 million in the period 2018–2021) and distribution infrastructure (EUR 18 million in the period 2018–2021) will be used in an effort to increase the number of electric cars to at least 250,000 and gas cars to at least 50,000 in Finland in 2030. Guidance by information is used to improve the level of knowledge of consumers and retailers about the environmental protection related to cars.	Ministry of Transport and Communications, Ministry of the Environment, Ministry of Finance
Measures reducing total kilometres driven in passenger cars in urban areas • Act on Transport Services • assessing local emission impacts and developing implementation while taking emissions and exposure into account • coordinating transport and land use, increasing the density of community structures, taking into account air quality, and the accessibility and development of public transport (through means such as town planning) • implementing the programme for the promotion of walking and cycling (see Table 14) • developing traffic taxation to favour low emission means of mobility	The Act on Transport Services will facilitate producing and harmonising new and old transport services. The increase in the services also results in a boost in their use rates, and mitigate the growth in the kilometres driven by passenger cars and related emissions. The improvement of the community structure aims at laying a foundation for organising public transport on one hand, and promoting walking and cycling by reducing local emissions on the other. The aim is to accomplish a 30% growth in journeys made on foot or by bicycle. The programme also includes an investment programme for supporting walking and cycling projects by municipalities (EUR 30 million). People will opt for low-emission means of mobility and modes of transport.	Ministry of Transport and Communications, Ministry of the Environment, Ministry of Finance, cities

Table 12b. Measures for reducing air pollutant emissions caused by road transport, particularly street dust

MEASURE	EFFECTS	PARTIES RESPONSIBLE
Implementing the recommendations of the Problems with Dusty Roads in Built-up Areas project, incl. • the joint planning of land use and transport (speeds, heavy traffic) • developing contractor agreements (fleet, dust binding, water-sieved crushed stone, time of cleaning) • determining the quality of surface materials	The volume of street dust will be reduced – resulting in a decline in adverse health effects and improved comfort	Finnish Transport Infrastructure Agency, cities
Enhancing the spread of the best practices in street cleaning and maintenance to municipalities and contractors. Setting best practices as selection criteria for procurements based on which contractors are selected.	A decline in adverse health effects, improved comfort Competence in environmental matters will improve among commissioners and contractors	Ministry of Transport and Communications, Association of Finnish Local and Regional Authorities, Finnish Environment Institute, municipalities
Increasing guidance by information on the best tyre options for motorists in terms of air quality and safety. Investigating use restrictions on studded tyres in certain areas.	A decline in adverse health effects, improved comfort Awareness of the effects of tyre choices will improve	Ministry of Transport and Communications, Association of Finnish Local and Regional Authorities, Finnish Environment Institute

6.2 Small-scale burning of wood

Small-scale burning of wood is the most significant emission source for fine particulate matter in Finland, causing around half of Finland's $PM_{2.5}$ emissions. Exposure to particles emitted from small-scale burning of wood has been estimated to cause around 200 premature deaths in Finland each year (Karvosenoja et al. 2017). While the emissions from other sources are projected to significantly decline under currently valid legislation, emissions from small-scale burning of wood appear to remain at the current level or drop only slightly. The impacts of the Commission Regulations 2015/1185 and 201571189 based on the Ecodesign Directive, which enter into force in 2020 and 2022, on small-scale burning of wood in Finland have been estimated to be fairly moderate by 2030. This is due to the fact that heat-retaining fireplaces are slowly renewed in Finland and as sauna stoves fall outside the scope of the directive. In other words, additional measures must be taken at the national level to reduce the adverse health effects caused by small-scale burning of wood.

The emissions from the small-scale burning of wood, and the opportunities for restricting the emissions and related health impacts have been widely explored in Finland (incl. Tissari 2008, Savolahti et al. 2016, Jalava et al. 2012, Salonen et al. 2015 and 2016). The promotion of the correct use of fireplaces and local space heaters and preferring wood-burning sauna stoves with lower emissions have been found as particularly suitable,

efficient and cost-effective approaches for reducing the adverse effects caused by small-scale burning of wood. Table 13 presents further measures based the aforementioned studies, among other sources.

Small-scale burning of wood is also the clearly biggest source of black carbon emissions in Finland. Black carbon is a contributor to climate warming, particularly emphasised in the Arctic region (e.g. AMAP Assessment 2015). Indeed, black carbon emissions must be taken into account in assessing the environmental effects of different heating systems.

Table 13. Measures for reducing the fine particulate matter emissions caused by the small-scale burning of wood

MEASURE	EFFECTS	PARTIES RESPONSIBLE
Enhancing guidance by information aimed at the general public and other agents: • Enhancing the spread of good communication practices to municipalities • Raising awareness of harm caused by small-scale burning of wood among the general public • Increasing information provision and instruction on the correct ways to use fireplaces • Utilising different means of communication (brochure, video, Twitter) • Cooperation with new operators (e.g. schools, recreational associations, areas with single-family detached housing, sauna clubs) • Launching cooperation with climate projects by municipalities (energy efficiency, emissions, air quality, human welfare)	Better small-scale burning approaches (ovens, fireplaces, sauna stoves) may reduce the fine particulate matter emissions caused by burning by a few per cent. Burning methods can also significantly affect the efficiency of fireplaces and therefore the amount of required wood. Awareness of the adverse health effects of the emissions may also reduce unnecessary fireplace use in urban areas. In this case, the reduction in emissions may be clearly bigger than estimated. The measure intends to reduce the exposure of the population to fine particulate matter, particularly in areas with a lot of small-scale burning of wood. The measure is also considered rather cost effective even with low effectiveness.	Municipalities, Helsinki Region Environmental Services Authority, Association of Finnish Local and Regional Authorities, Ministry of the Environment, Finnish Environment Institute, Ministry of Social Affairs and Health, National Institute for Health and Welfare, Ministry of Education and Culture Central Association of Chimney Sweeps, Finnish Home Owners' Association, Organisation for Respiratory Health, Allergy, Skin and Asthma Federation
Reducing the harm caused by polluting wood-burning sauna stoves: • Determining the opportunities for setting technical requirements for sauna stoves (incl. low emission criteria, R&D project) • Determining the opportunities for entering into voluntary agreements (e.g. green deal agreements) with sauna stove manufacturers • Finding out whether incentives can be introduced for the renewal of sauna stoves	These are necessary basic measures for introducing low emissions sauna stoves to the market.	Ministry of the Environment, Ministry of Finances, sauna stove manufacturers, research institutes, Finnish Fireplace Association

MEASURE	EFFECTS	PARTIES RESPONSIBLE
Enhancing the prevention of smoke hazards: • Updating the health guidelines on small-scale burning of wood (STTV: Guides 6:2008) as better suited as tools for the health and environmental protection authorities than currently. The instructions should also make clear that legislation beyond the Health Protection Act may be applied in the smoke hazards caused by small-scale burning of wood. • Developing measurement technology with practical application to ensure the reliability of the measurements related to the monitoring of smoke hazards. • Encouraging people to change their old fireplaces and boilers as well as boilers without hot water back boilers to low emissions equivalents. Investigating the opportunities for introducing incentives. • Creating a model and piloting good practices for preventing the smoke hazards of wood burning in building regulations, building method instructions, and the terms of purchase of plots. • Recommending the construction of wood storage in real property with a wood-burning fireplace or boiler.The measures are key basic actions for reducing smoke hazards.	The measures are key basic actions for reducing smoke hazards. Will influence the activities of the environmental and health protection authorities. Need for developing joint operating approaches. The measurement method would provide information of ambient air pollution caused by the smoke from small-scale burning of wood as well as the travel of air pollutants from outside to the inside of homes. The information could be utilised in local communications targeting the residents of small single-family homes. Moderately priced, objective tools would supplement the currently used subjective, sensory-based monitoring of smoke hazards, making the detection of smoke hazards easier than currently. Obtaining this evidence would accelerate the elimination of using poor fireplaces and wood-burning boilers with high emissions used for burning wood by restricting combustion air flow as primary hearing sources for central heating purposes. The terms of construction may affect the emergence of smoke hazards. The correct storage of wood can affect wood quality and therefore emissions.	Ministry of the Environment, Ministry of Social Affairs and Health, National Institute for Health and Welfare, National Supervisory Authority for Welfare and Health, municipalities, Finnish Home Owners' Association

6.3 Taking air pollution control into account in the planning and decision-making of other sectors

Good air quality reduces morbidity and increases comfort. In addition to technical emissions reduction measures, the good development of air quality will also require taking the subject into account systematically in all strategies, programmes and projects of different sectors affecting air pollution control and related implementation. This means making air pollution control visible as a factor influencing policies in the planning and decision-making related to the strategies, programmes and projects, and also incorporating it in the health and environmental impact assessment of the measures carried out in different sectors. The sectors most crucial for air pollution control include the land use, town planning, energy, climate, transport, agricultural and welfare sectors. The measures of the transport sector are also discussed in section 6.1.

The progress of climate change also directly affects human health. For instance, as average winter temperatures rise, slippery conditions become more commonplace, which increases accident risk on one hand and a need for sanding on the other, the latter of which contributes to the street dust problem. These health impacts should be recognised and taken into consideration. Additionally, more attention should be paid to the fact that a number of climate measures, such as the improvement of energy efficiency and promotion of bicycle use, also improve local air quality. On the other hand, some climate measures may also result in a decline in air quality, for instance, as increasing the density of community structures may cause the formation of street canyons. Indeed, climate change mitigation efforts should highlight measures that also improve air quality.

The work promoting air pollution control should aim at utilising the programme and organisational structures formed for the purpose of combating climate change, as the agents involved in these are largely the same. The practical measures of air pollution control and work related to climate change both often take place at the municipal level. Municipalities are involved in a number of national and international programmes and networks which take measures to mitigate and adjust to climate change. Municipalities are also involved in networks aiming to share good welfare and health promotion practices.[43]

Table 14 presents the connections and effects of the current strategies, programmes and projects applying to various sectors on air quality and includes measures for taking air pollution control into consideration in these contexts better than currently. In addition to the implementation, air quality issues should also be taken into account in updating these instruments.

In turn, Table 15 presents projects linked to the air pollution control efforts by municipalities, and proposes measures for taking air pollution control into account better than currently in this context.

43 https://thl.fi/fi/web/hyvinvoinnin-ja-terveyden-edistamisen-johtaminen/kansallinen-tuki-ja-verkostot/terve-kunta-verkosto

Table 14. The connections and effects of the current strategies, programmes and projects on air quality and measures for taking air pollution control into consideration in these contexts better than currently

Strategy or programme affecting air quality	The key measures and effects affecting air quality in the strategy/programme	Measure	Effects, cost perspectives	Parties responsible
All		Increasing knowledge basis and related applicability on the health impacts and harm-related costs of air quality, and using this to influence taking air quality and health impacts into account as factors affecting policies in different projects		Finnish Environment Institute, National Institute for Health and Welfare, Finnish Meteorological Institute
National Energy and Climate Strategy (2017)	Many of the measures included in the strategy also primarily improve air quality (phasing coal out as an energy source by 1 May 2029, reducing the total number of kilometres driven, increasing the number of electric and gas cars)	Influencing taking air quality and health impacts into account as a factor affecting the policies in connection with a strategy update, e.g. by concretely demonstrating the monetary value of related health benefits. This can be affected by measures such as complementing the instructions by the authorities and the assessment of the environmental effects in the programmes with a section that gives instructions on calculating the monetary value of health benefits achieved through air pollution control measures.	Human health and comfort will be improved as climate measures also promote good development of air quality. This is often achieved without additional costs as the sources of greenhouse gases and local emissions are primarily the same. The concrete monetary value of the health benefits achieved through air pollution control is used to draw attention to the opportunities for reducing total health costs in society through air pollution control measures (savings to the national economy).	Ministry of Economic Affairs and Employment, Ministry of the Environment, Ministry of Transport and Communications, Ministry of Social Affairs and Health, Ministry of Agriculture and Forestry, Ministry of Finances
Medium-term climate change policy plan (KAISU, 2017)	Many of the measures included in the Medium-term Climate Change Policy will also primarily improve air quality (electric cars, low emission machinery, stricter emission standards for road transport, promotion of small-scale burning of wood).	Influencing that the implementation of the Medium-term Climate Change Policy takes air quality and health impacts into account as a factor affecting the policies. This can be affected by measures such as complementing the instructions by the authorities and the assessment of the environmental effects in the programmes with a section that gives instructions on calculating the monetary value of health benefits achieved through air pollution control measures.	Human health and comfort will be improved as climate measures also promote good development of air quality. This is often achieved without additional costs as the sources of greenhouse gases and local emissions are primarily the same. Many of the measures are implemented in municipalities close to general public, which means that people get to quickly enjoy the effects of the measures improving air quality. The concrete monetary value of the health benefits achieved through air pollution control is used to draw attention to the opportunities for reducing total health costs in society through air pollution control measures (savings to the national economy).	Ministry of the Environment, Ministry of Transport and Communications, Ministry of Economic Affairs and Employment, municipalities
Programme for the promotion of walking and cycling (Ministry of Transport and Communications, 2017)	All measures promoting an increase in walking and cycling also improve air quality. Measures related to the development of the community structure (incl. MAL Agreements and related assessment criteria), location of services and planning of the transport system are particularly significant.	Supporting the implementation of the programme, in particular the development of assessment criteria related to the sustainability and effects on local emissions of MAL Agreements, including the monetary value of health benefits achieved through air pollution control measures. The utilisation of the developed assessment criteria in all projects is also supported.	The utilisation of assessment criteria related to the sustainability and effects on the local environment of MAL Agreements will be established as part of municipal, regional and national planning and implementation of measures. Cycling and pedestrian routes will have better air quality than currently.	Ministry of Transport and Communications, Ministry of the Environment, municipalities
Interim report by the Transport Climate Policy working group: Carbon-free transport by 2045 – Paths to an emission-free future (Ministry of Transport and Communications, 2018)	In the BIO, TECHNO and SERVICE scenarios, the reduction in carbon dioxide emissions is based on different alternatives, all of which would probably also reduce air pollutants. The SERVICE scenario involves a reduction in the total number of kilometres driven and improvement in energy efficiency, which would also cut air pollution. The starting point for all three scenarios is a principle based on which polluters must constantly pay more.	Supporting the implementation of the proposals by taking into account air quality and health impacts as well as the monetary value of health benefits as a factor affecting the policies. Ensuring that the air quality perspective, including related health benefits, is taken into consideration when assessing the effects of the scenarios.	Human health and comfort will be improved as policies concerning climate measures also promote good development of air quality. In principle, this can be achieved without additional costs as the sources of greenhouse gases and local emissions are primarily the same.	Ministry of Transport and Communications, Ministry of the Environment

Table 15. Current projects linked to the air pollution control efforts by municipalities, and proposed measures for taking air pollution control better into account in this context.

Projects by municipalities affecting air quality	Connection of the project with air quality (activities and effects)	Measure	Effects and cost perspectives
All projects	Municipalities are actively involved in projects and networks concerning climate and otherwise affecting air quality, and these may also serve as structures for promoting measures aiming to improve air quality.	Increasing impact assessment carried out in cooperation between industries. Joining air quality targets to the ongoing programmes and projects. Including air quality as a visible part of projects with key importance to air pollution control. Increasing motivation with the Arctic climate impacts caused by black carbon in addition to health impacts. In an effort to join air quality aspects to the ongoing and soon launched project, a project selecting and highlighting measures that will also improve air quality and reduce exposure and adverse health effects among the population from climate projects will be launched.	This will allow accomplishing air quality and health benefits in addition to those related to climate. Preventing the implementation of measures deteriorating air quality. Land use, transport, energy production. Street dust and small-scale burning of wood.
Energy Efficiency Agreements 2017–2025	Improving the efficiency of energy use and production usually reduces fuel consumption that causes emissions.	Encouraging operators to join the activities subject to the agreement to ensure that the agreement coverage will be even better than currently.	The coverage of energy saving agreements is also likely to reduce local emissions.
The implementation of the medium-term climate change policy plan in municipalities and regions ("KuntaKaisu")	The measures by municipalities in climate change mitigation also often improve air quality at the local level and influence black carbon emissions.	Selecting KuntaKaisu projects in which the promotion of air quality is a natural fit. Spreading the best practices forward in a spirit of dual benefits.	The goals of air pollution control are taken into better consideration in climate change mitigation at the local level, which will result in improved human health and comfort, i.e. accomplishment of quick benefits.
The IlmastoKunnat ('Climate-friendly Municipalities') activities of the Association of Finnish Local and Regional Authorities	A network open for everyone aiming to bring together different types of municipalities and supporting their climate-related effort while taking the municipalities' special characteristics into account.	Developing the platform to make the air quality perspective sufficiently and appropriately visible.	Local climate-related work will take air quality into account alongside climate change mitigation, and this will allow accomplishing positive effects related to health and comfort.
The HINKU Forum	The aim is to reduce municipalities' greenhouse gas emissions by 80% from the level of 2007 by 2030.	The Finnish Environment Institute will continue its role as a catalyst for air quality in the HINKU projects.	Air quality will be taken into account and measures to improve it will be taken.
The Healthy Cities network	Supports the dissemination of good practices for promoting health and welfare.	Introducing the air quality and living environment perspective as part of the network's tasks. This allows utilising the available cooperation structure and including new contents to it.	Air quality will be included in health and wellbeing promotion.
MAL Agreements	Cooperation between municipalities and the state in developing the community structure will affect air quality.	Supporting the development of assessment criteria related to the sustainability and effe-cts on local emissions of MAL Agreements, including the monetary value of health benefits achieved through air pollution control measures. The utilisation of the developed assessment criteria is also supported in all projects.	The utilisation of assessment criteria related to the sustainability and effects on the local environment of MAL Agreements will be established as part of municipal, regional and national planning and implementation of measures.
Municipal strategy (for each local council term)	The achievement of municipal strategy objectives is monitored through means such as the extensive wellbeing report, which is prepared once every local council term. Municipalities can include indicators related to the living environment and air quality in their wellbeing reports.	Development of environmental health indicators	Monitoring the effectiveness of measures affecting air quality

6.4 Other measures

Table 16 presents general measures concerning the development of air pollution control and related communications for promoting air pollution control in Finland.

Table 16. Other measures promoting air pollution control.

MEASURE	EFFECTS	PARTIES RESPONSIBLE
Supporting the air pollution control efforts by municipalities	The aim is to integrate the air pollution control efforts by municipalities more closely to climate-related work in cases where this integration will produce cost savings, and enhance the activities and resource use.	Ministry of the Environment, Ministry of Social Affairs and Health, Ministry of Economic Affairs and Employment, Ministry of Transport and Communications, Finnish Environment Institute, Finnish Meteorological Institute, National Institute for Health and Welfare
Enhancing and developing the communications on air pollution control in cooperation with other agents	The aim is that the members of general public and decision-makers will receive information that is easy to understand on air quality and its effects on health as well as the costs of the adverse effects of poor air quality. Widely utilising old and new communication channels.	Municipalities, Ministry of the Environment, Ministry of Social Affairs and Health, Ministry of Economic Affairs and Employment, Ministry of Transport and Communications, Finnish Environment Institute, Finnish Meteorological Institute, National Institute for Health and Welfare, Helsinki Region Environmental Services Authority, Organisation for Respiratory Health, others
Developing websites about air quality and emissions to be more customer-oriented	The aim is to provide comprehensive information about air quality at the air quality webpage of the Finnish Meteorological Institute, including measurement station specific real time calculations of the exceedances of the EU's daily limit values set for respirable particles (PM_{10}) and the exceedances of the WHO's daily guideline values set for fine particulate matter ($PM_{2.5}$). The emissions data will be produced on a map template on the website, which enables utilising the data in selecting a place of residence and developing living environments.	Finnish Meteorological Institute, municipalities, Finnish Environment Institute, Helsinki Region Environmental Services Authority
Launching a training project on calculating the costs of the adverse effects of air pollutants	Disseminating data on the costs of adverse effects to practice, e.g. with the IHKU model, will increase competence in the effects of air quality and introduce this into decision-making.	Ministry of the Environment, Finnish Environment Institute, National Institute for Health and Welfare, Association of Finnish Local and Regional Authorities
Participating in the WHO's scientific assessment to revise the guideline values for air quality	The aim is to update WHO's guideline values to conform to the latest scientific research.	National Institute for Health and Welfare
Influencing tightening EU's limit values for air quality	The purpose is that the limit value set by the EU for air quality will be updated to correspond to WHO's recommendations as well as possible. The majority of Finland's air pollution concentrations result from long-range transboundary air pollution, and Finland benefits from emission reductions made in other countries.	Ministry of the Environment, Finnish Environment Institute, National Institute for Health and Welfare, Finnish Meteorological Institute
An air pollution control ambassador for schools and organisations project	Raising awareness of air pollution control, through which different agents will promote the cause.	Ministry of Education and Culture, Ministry of the Environment, Ministry of Social Affairs and Health, Finnish Environment Institute, Finnish Meteorological Institute, National Institute for Health and Welfare

7 Monitoring the implementation and impacts of the Air Pollution Control Programme

7.1 Monitoring the development of emissions

Assessments of air pollutant emissions have already been prepared under international conventions for the following compounds: since 1980: sulphur compounds as sulphur dioxide (SO_2), nitrogen compounds as nitrogen dioxide (NO2), ammonia (NH_3); since 1987: non-methane volatile organic compounds (NMVOC); since 1990: carbon monoxide (CO), heavy metals (As, Cd, Cr, Cu, Hg, Ni, Pb, V and Zn) and POP compounds (PCDD/F, PAH-4, HCB, PCB, HCH, PCP, SCCP); and since 2000: particulate matter (TSP, PM_{10}, $PM_{2.5}$ and black carbon). The guidelines of international conventions on emission sources and the reported compounds are constantly supplemented and changing.

Data on the emissions of atmospheric pollutants are annually submitted to the European Commission in accordance with the NEC Directive (2016/2284), the Secretariat for the Convention on Long-Range Transboundary Air Pollution of the UN Economic Commission for Europe, and the Stockholm Convention on Persistent Organic Pollutants of the UN Environment Programme. The pollutant emission data is also used in Finland's reporting for the United Nations Framework Convention on Climate Change (NMVOC compounds).

The Finnish Environment Institute is responsible for national emission inventories and projections as well as informative inventory reports under the NEC Directive. The inventory covers all sulphur dioxide emissions, nitrogen oxide emissions, ammonia emissions, volatile organic compound emissions, fine particulate matter emissions ($PM_{2.5}$) and respirable particle (PM_{10}) emissions, carbon monoxide emissions, the emissions of certain heavy metals (Cd, Hg, Pb), the emissions of persistent organic pollutants (total volume of PAH compounds, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, Indeno(1,2,3-cd)pyrene, dioxins and furans, PCB compounds and HCB), and black carbon (BC) emissions.

The Finnish Environment Institute publishes the emission inventories and projections as well as informative inventory reports through the public information network.[44] The emission data is available per time series, emission source and geographic location, and the informative inventory report (IIR) is available in English.[45]

7.2 Monitoring the ecological impacts of emissions

The NEC Directive requires the ecological monitoring of the harmful impacts of atmospheric pollutants.

The number of ecosystems subject to the monitoring depends on the Member State's biogeographical status and the ecosystem types in the country. EU's territory has been divided into 11 biogeographical regions. Of these, the alpine region (Northern Lapland) and boreal region cover Finland.

The significant ecosystems in Finland that will be subject to the monitoring of the impacts of acidification and eutrophication are fresh surface water, forests and peatlands. Forests and agricultural land are included in the ozone stress monitoring. In Finland, the monitoring of ecological impacts in accordance with Article 9 of the NEC Directive is conducted on 34 monitoring sites (Figure 25). The monitoring of impacts also takes into account the results of the monitoring conducted in the Baltic Sea region.

The Environmental Protection Act and Decree lay down provisions on the national implementation of the ecological impact monitoring of atmospheric sulphur and nitrogen emissions under the NEC Directive. The Environmental Protection Act defines the responsibilities for organising this monitoring as well as the monitoring of ozone stress between the Finnish Environment Institute, ELY Centres, Natural Resources Institute Finland, Finnish Meteorological Institute and Ministry of the Environment. The Finnish Environment Institute reports the compiled data on ecological impact monitoring to the Commission and the European Environment Agency (EEA). The Institute also publishes the data through an open information network.

44 Air pollutant emissions

45 Informative Inventory Report

Fresh surface water

Monitoring of the impacts of atmospheric acidification and eutrophication takes place at 24 fresh surface water monitoring sites (19 lakes, 5 brooks), which cover geographically different deposition and climate conditions (Figure 25). The monitoring targets are nutrient-poor forest lakes and brooks located in headwater regions vulnerable to the impacts of air pollution and prone to reflect changes in atmospheric stress. The Finnish Environment Institute and ELY Centres are the institutions in charge of monitoring ecological impacts on surface water.

Woodlands and peatlands

The ecological impact monitoring of woodland ecosystems in accordance with the National Emission Ceilings Directive is carried out at three stations included in the ICP Forests level II/ICP IM programmes (Figure 25). The monitored areas are located in protected territories and represent geographically diverse deposition and climate conditions. The monitoring sites are primarily conifer-dominated catchment areas whose nutrient-poor soil is vulnerable to the impacts of air pollution. Natural Resources Institute Finland is the institute in charge of the ecological impact monitoring of woodland areas.

Organising the ecological impact monitoring referred to by the NEC Directive on peatlands does not require monitoring with constant activities. This would rather be a case of monitoring conducted at 5–10-year intervals of the impacts of atmospheric pollutant load on vegetation and the chemical status of soil. The monitored peatlands are also located in the ICP IM areas (Figure 25) that represent different peatland types, including wooded mires, pine mires and treeless mires, and raised bogs and aapa mires as peatland complex types. The Ministry of the Environment is responsible for the ecological impact monitoring conducted in peatland areas by commissioning the monitoring referred to by Article 9 of the NEC Directive as separate projects carried out multi-yearly.

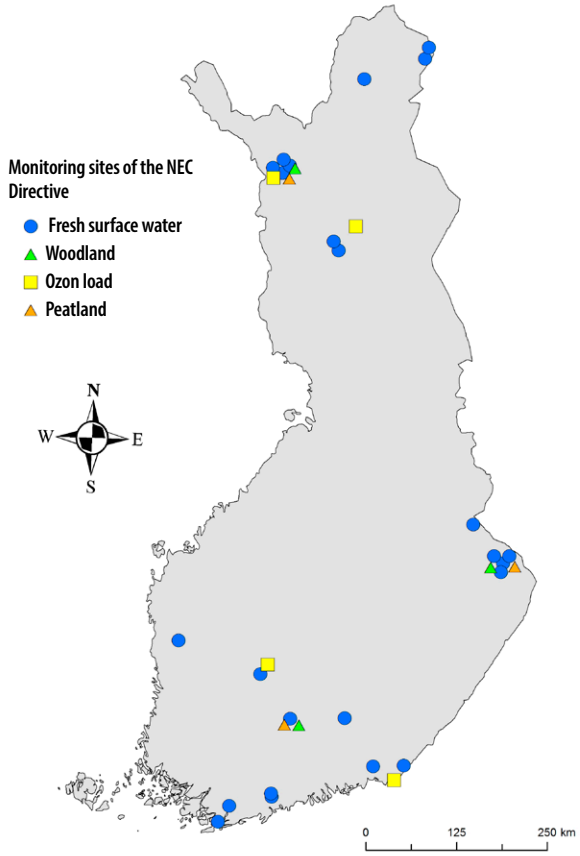


Figure 25. **The sites of ecological impact monitoring under Article 9 of the NEC Directive.**

Ozone

The NEC Directive requires the monitoring of ozone stress for assessing the damage caused to vegetation growth and biodiversity. Ozone stress monitoring is carried out at four stations belonging to international measuring programmes (Figure 25). The conditions at three of the stations represent woodland areas and one cultivated land. The Finnish Meteorological Institute is the agency in charge of ozone stress monitoring.

7.3 Air quality monitoring

Municipalities and the Finnish Meteorological Institute primarily carry out the air quality monitoring conducted in Finland. In addition, the Finnish Meteorological Institute serves as the national air quality reference laboratory with a key role in ensuring that the quality of air quality monitoring is uniform. The tasks of the national reference laboratory include ensuring and supporting the cohesive quality of the measurement network by organising reference measurements and training.

The most commonly measured compounds include particulate matter (PM_{10} and $PM_{2.5}$) and nitrogen dioxide. In municipalities, air quality measurement activities are implemented with a decentralised approach, meaning that air quality is measured in the area of around 60 municipalities at 100 measurement stations which form around 30 measurement networks (Figure 26). The extent and resources of the networks' measurement activities vary considerably from a network covering one measurement station to those consisting of over ten stations reaching the areas of several municipalities. The local industry causing emission in the region often participates in the measurement activities and its financing (joint monitoring), but may also have its own measurement network. Air quality data is compiled to a database maintained by the Finnish Meteorological Institute, which is part of the environmental protection data network. The Finnish Meteorological Institute publishes the current data[46] and further reports them to the European Commission.

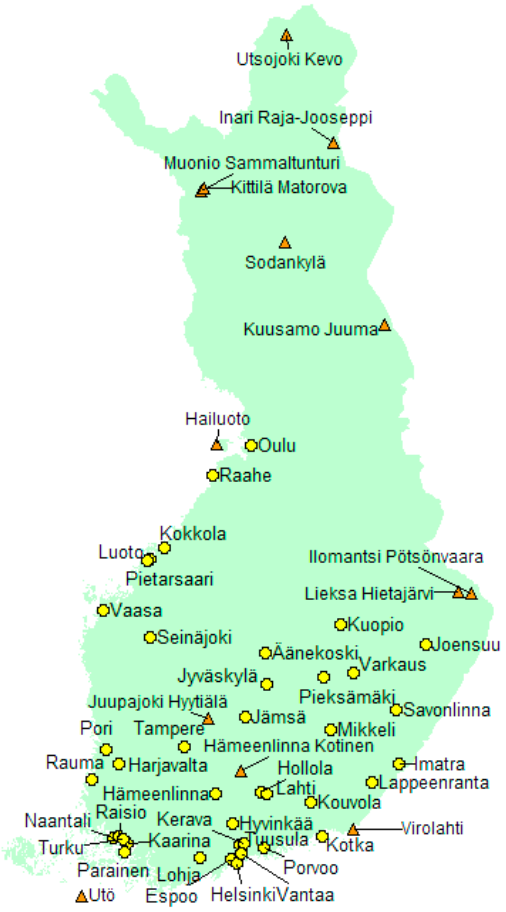


Figure 26. Finland's air quality monitoring network

46 https://ilmatieteenlaitos.fi/ilmanlaatu

7.4 Monitoring measures included in the Air Pollution Control Programme

The measures approved in the Air Pollution Control Programme are implemented in cooperation with various responsible parties. The implementation of the measures presented in the baseline scenarios of chapter 5 is assessed as part of the development of emissions referred to in section 7.1.

To support and monitor the realisation of the measures proposed in the programme, the Ministry of the Environment establishes a monitoring network, to which it will invite key agents in charge of the implementation of the programme. The achievement of the measures suggested in chapter 6 will be assessed by separate studies carried out in 2026 and 2031. The Ministry of the Environment will be in charge of conducting the assessments in collaboration with the Finnish Environment Institute.

References

Ahtoniemi P., Tainio M., Tuomisto J. T., Karvosenoja N., Kupiainen K., Porvari P., Karppinen A., Kangas L., Kukkonen J. 2010. Health Risks from Nearby Sources of Fine Particulate Matter: Domestic Wood Combustion and Road Traffic (PILTTI). Health risks from nearby sources of fine particulate matter : Domestic wood combustion and road traffic (PILTTI). National Institute for Health and Welfare REPORT 3/2010. http://www.thl.fi/thl-client/pdfs/821ba678-1430- 4016-bfc8-77a40c49eb1f

EEA 2014 NEC Directive status report 2013. EEA Technical report No10/2014, p. 17.

EEA 2017a. Air Quality in Europe – 2017 report. EEA Report No 13/2017. https://publications.europa.eu/fi/publication-detail/-/publication/d17e4630-aefa-11e7-837e-01aa75ed71a1

EEA 2017b, Exposure of ecosystems to acidification, eutrophication and ozone, Indicator CSI 005, European Environment Agency https://www.eea.europa.eu/data-and-maps/indicators/exposure-of-ecosys- tems-to-acidification-14/assessment

EMEP 2014. Transboundary particulate matter, photo-oxidants, acidifying and eutrophying components.

EMEP 2016. Country Reports (Gauss, M., Nyiri, A., Benedictow, C., Klein, H.). Transboundary air pollution by main pollutants (S, N, O3) and PM. MSC-W Data Note 1/2016 Individual Country Reports (Finland). http://www.emep.int/mscw/mscw_datanotes.html

EMEP Status Report 2016. Fagerli, H. et al. Transboundary particulate matter, photo-oxidants, acidifying and eutrophying components. http://emep.int/publ/reports/2016/EMEP_Status_Report_1_2016.pdf

Grönroos, J. Munther, J., Luostarinen, S. 2017. Calculation of atmospheric nitrogen and NMVOC emissions from Finnish agriculture. Description of the revised model. Reports of the Finnish Environment Institute 37/2017. 60 p.

Hettelingh, J.-P., Posch, M., Slootweg, J. 2017. European critical loads: database, biodiversity and ecosystems at risk. CCE Final Report 2017. https://wgecce.org/Publications/CCE_Status_Reports/CCE_FINAL_REPORT_2017

Holmberg, M., Leikola, N., Forsius, M., Raunio, A., Mäkelä, K., Vuorenmaa, J., Salemaa, M., 2011. Finland National Focal Centre. In: Posch, M., Slootweg, J., Hettelingh, J.-P. (eds.) Modelling critical thresholds and temporal changes of geochemistry and vegetation diversity: CCE Status Report 2011. RIVM Report 680359003, Bilthoven, Netherlands, p.91-97; http://www.rivm.nl/media/documenten/cce/Publications/SR2011/CCE_Report-2011_Finland.pdf

Holmberg, M., Forsius, M., Posch, M. 2017. Finland National Focal Centre. In: Hettelingh, J.-P., Posch, M., Slootweg, J. 2017. European critical loads: database, biodiversity and ecosystems at risk. CCE Final Report 2017. p. 97-99. http://www.rivm.nl/media/documenten/cce/Publications/SR2017/Finland.pdf https://wge-cce.org/Publications/CCE_Status_Reports/CCE_FINAL_REPORT_2017

Huttunen R. (ed.) 2017. Government report on the National Energy and Climate Strategy for 2030. Publications of the Ministry of Economic Affairs and Employment 4/2017. 119 pp.

Hänninen O., Leino O., Kuusisto E., Komulainen H., Meriläinen P., Haverinen-Shaugnessy U., Miettinen I., Pekkanen J. 2010. Elinympäristön altisteiden terveysvaiktukset Suomessa. Ympäristö ja Terveys 3/2010:12-35. http://urn.fi/URN:NBN:fi-fe201503252018

Jalava P.I, Happo M.S., Kelz J., Brunner T., Hakulinen P., Mäki-Paakkanen J., Hukkanen A., Jokiniemi J., Obernberger I. & Hirvonen M-R. 2012. In vitro toxicological characterization of particulate emissions from old and new technology residential biomass heating systems. Atmospheric Environment 50, 24-35

Karvosenoja, N. 2008. Emission scenario model for regional air pollution. Monographs Boreal Environ. Res. 32.
Karvosenoja N., Savolahti M., Lanki T., Salonen R. & Tiittanen P. 2017. Chapter 4.7 Vaikutukset ilmanlaatuun In the rport: Soimakallio S., Hildén M., Lanki T., Eskelinen H., Karvosenoja N., Kuusipalo H., Lepistö A., Mattila T., Mela H., Nissinen A., Ristimäki M., Rehunen A., Repo A., Salonen R., Savolahti M., Seppälä J., Tiittanen P., Virtanen S. 2017. Environmental impact assessment of the Energy and Climate strategy and medium-term climate change policy plan. Publications of the Government's analysis, assessment and research activities 59/2017.

Kupiainen K., Ana Stojiljkovic, Ville-Veikko Paunu, Niko Karvosenoja, Ari Karppinen, Jaakko Kukkonen, Leena Kangas, Mari Kauhaniemi, Bruce Denby, Otto Hänninen 2018. Characteristics and Mitigation of Vehicular Non-Exhaust Particle Emissions in Nordic Conditions. ITM 2018, 36th International Technical Meeting on Air Pollution Modelling and its Application, 14-18 May 2018, Ottawa, Canada. Extended abstract 4 pp.

Ministry of Agriculture and Forestry 2018. Action programme for reducing the ammonia emissions originating from agriculture in Finland. Publications of the Ministry of Agriculture and Forestry 1/2018

Salonen, R.O., Pasanen, K., Pulkkinen, A.-M., Pennanen, A., Sokura, M., Pärjälä, E., Pukkala, E. 2015.Puun pienpolton savut: uutta tietoa altistumisesta ja terveyshaitoista. Ympäristö ja Terveys 6/2015: 4-11. http://urn. fi/URN:NBN:fi-fe2015103015772.

Salonen, R.O., Pasanen, K., Pulkkinen, A.-M., Pennanen, A., Pärjälä, E., Koskentalo, T., Pukkala, E. 2016 Puun pienpolton savuja ulkoa sisälle ja pitkäaikaisesta altistumisesta syöpiä (2016) Ympäristö ja Terveys 8/2016: 28-39. http://urn.fi/URN:NBN:fi-fe201702281887

Savolahti M., Kangas L., Karppinen A., Karvosenoja N., Kukkonen J., Lanki T., Nurmi V., Palamarchuk Y., Paunu V-V., Sofiev M. & Tiittanen P. 2018. Air Pollution Damage Cost Model for Finland (IHKU) Publications of the Government's analysis, assessment and research activities 26/2018

Savolahti M., Karvosenoja N., Tissari J., Kupiainen K., Sippula O., Jokiniemi J. 2016. Black carbon and fine particle emissions in Finnish residential wood combustion: Emission projections, reduction measures and the impact of combustion practices. Atmospheric Environment 140:495–505.

Suoheimo, P., Grönroos, J., Karvosenoja, N., Petäjä, J., Saarinen, K., Savolahti, M., Silvo K. 2015. Päästökattodirektiiviehdotuksen ja keskisuurten polttolaitosten direktiiviehdotuksen toimeenpanon vaikutukset Suomessa https://helda.helsinki.fi/handle/10138/153981

Tissari, J. 2008. Fine Particle Emissions from Residential Wood Combustion. Doctoral dissertation. Kuopio university publications C Natural and environmental sciences 237.

Ministry of the Environment 2002. Air Pollution Control Programme 2010. A programme adopted by the Government on 26 September 2002 on the implementation of Directive (2001/81/EC). The Finnish Environment 588. p. 38 https://helda.helsinki.fi/ handle/10138/40581

Ministry of the Environment 2016. Ilmansaasteiden terveysvaikutukset. Ministry of the Environment report 16/2016.

Ministry of the Environment 2017. Government Report on Medium-term Climate Change Plan for 2030 – Towards Climate-Smart Day-to-Day Living. Reports of the Ministry of the Environment 21/2017. 142 pp.

Appendix 1. The reported (2005, 2010, 2015) and modelled (2020, 2025, 2030) air pollutant emissions

The table only contains the emissions sectors included in the reduction commitments set by the National Emission Ceilings Directive. Some of the numbers for the period 2005–2015 are preliminary figures of updates to performed on the inventory, which means that they may differ from the reported values.

Emissions kt/a	2005	2010	2015	2020	2025	2030
SO_2						
Energy production and industrial incineration	51.6	53.4	32.2	23.2	19.0	18.7
Industrial processes	8.7	5.3	4.0	2.9	2.4	2.3
Small-scale burning of wood	6.6	6.0	3.9	3.2	3.3	3.2
Road transport	0.1	0.1	0.0	0.0	0.0	0.0
Machinery and other transport	1.9	1.3	0.2	0.2	0.1	0.1
Other (e.g. agriculture and peat production)	0.7	0.1	0.5	0.4	0.2	0.1
Total	69.6	66.2	40.8	29.9	25.0	24.4
NOx						
Energy production and industrial incineration	66.8	76.0	53.1	52.0	41.9	42.1
Industrial processes	0.7	0.6	0.6	0.6	0.5	0.5
Small-scale burning of wood	11.3	12.2	7.9	7.7	7.7	7.5
Road transport	74.7	49.7	35.8	26.3	17.8	13.1
Machinery and other transport	41.7	35.2	24.9	20.0	15.7	13.0
Other (e.g. agriculture and peat production)	0.1	0.1	0.1	0.3	0.6	0.6
Total	195.3	173.8	122.4	106.9	84.2	76.6
$PM_{2.5}$						
Energy production and industrial incineration	3.8	2.5	2.5	2.3	1.8	1.8
Industrial processes	3.4	2.6	2.1	1.9	1.5	1.5
Small-scale burning of wood	10.4	13.7	10.2	9.2	9.0	8.7
Road transport	3.0	1.8	1.1	0.6	0.5	0.4
Street dust	1.1	1.1	1.1	1.2	1.2	1.2
Machinery and other transport	3.2	2.2	1.5	1.1	0.7	0.6
Other (e.g. agriculture and peat production)	2.9	2.4	1.6	1.5	1.5	1.4
Total	27.8	26.3	20.1	17.7	16.3	15.7
NMVOC						
Energy production and industrial incineration	1.5	2.0	1.7	1.7	1.7	1.7
Industrial processes	25.7	20.2	14.0	13.7	13.7	13.7
Small-scale burning of wood	17.9	23.8	17.9	17.0	16.6	16.3
Road transport	25.1	12.9	7.1	3.0	2.0	1.8
Machinery and other transport	30.5	16.6	11.7	8.2	7.0	6.2
Other (e.g. agriculture and peat production)	21.6	20.1	16.2	16.1	16.0	16.0
Total	122.3	95.6	68.6	59.7	57.0	55.7

Emissions kt/a	2005	2010	2015	2020	2025	2030
NH_3						
Energy production and industrial incineration	0.0	0.0	0.0	0.0	0.0	0.0
Industrial processes	2.1	0.6	0.5	0.5	0.5	0.5
Small-scale burning of wood	0.8	1.0	0.8	0.8	0.8	0.8
Road transport	2.0	1.6	1.1	1.0	1.0	1.0
Machinery and other transport	0.0	0.0	0.0	0.0	0.0	0.0
Agriculture	31.7	31.0	28.5	26.1	25.1	24.6
Total	36.6	34.2	30.9	28.4	27.4	26.9
BC						
Energy production and industrial incineration	0.2	0.2	0.2	0.1	0.1	0.1
Industrial processes	0.0	0.0	0.0	0.0	0.0	0.0
Small-scale burning of wood	3.1	4.1	3.0	2.7	2.6	2.5
Road transport	1.6	0.9	0.6	0.3	0.2	0.1
Street dust	0.2	0.2	0.2	0.2	0.2	0.2
Machinery and other transport	1.3	0.9	0.6	0.3	0.2	0.1
Other (e.g. agriculture and peat production)	0.0	0.0	0.0	0.0	0.0	0.0
Yhteensä	6.4	6.3	4.6	3.6	3.3	2.9
CH4						
Fuel consumption	17.9	18.8	14.0	14.0	14.0	14.0
Waste processing	106.7	96.4	72.0	50.0	41.0	32.0
Agriculture	90.9	90.7	92.0	93.0	89.5	86.0
Total	215.5	205.9	178.0	157.0	144.5	132.0

Appendix 2. Air pollution control legislation

Environmental Protection Act 527/2014

Environmental Protection Decree 713/2014

Climate Change Act 609/2015

Government decree on air quality 79/2017

Government decree relating to arsenic, cadmium, mercury, nickel and polycyclic aromatic hydrocarbons in ambient air 113/2017

Government Decree on Limiting Emissions from Large Combustion Plants 936/2014

Government Decree on Environmental Protection Requirements for Medium–sized Energy Production Units 1065/2017

Government Decree on Limiting Certain Emissions from Agriculture 1250/2014

Appendix 3. Measures of the Energy and Climate Strategy for 2030 affecting air pollution control

Energy and Climate Strategy	Finland will phase out the consumption of black coal for energy with minor exceptions.
Energy and Climate Strategy	The share of transport biofuel will be increased to 30 per cent, and an obligation to blend light fuel oil used for heating and in machinery with 10% of bioliquid. The goal is that at least 250,000 cars will run on electricity and 50,000 on gas by the year 2030.
Energy and Climate Strategy	Technology neutral calls for tenders will be prepared for the period 2018—2020, and these will be used as the basis for granting aid to cost-effective, new electricity production based on renewable energy.
Energy and Climate Strategy	The share of renewable energy of the final energy consumption will reach around 50 per cent and Finland's self-sufficiency in energy supply will increase to 55%. The domestic consumption of imported oil will be halved as planned.

Appendix 4. Measures of the medium-term climate change policy plan for 2030 (KAISU) affecting air pollution control

KAISU/Transport and land use	Replacing fossil fuels with renewable and low emission fuels and power sources.
KAISU/Transport and land use	Improving the energy efficiency of vehicles and other means of transport
KAISU/Transport and land use	Improving the energy efficiency of the transport system, including the impact that the development of land use will have on emissions. • The State will participate in the coordination of transport and land use in urban regions and in measures concerning the transport system, for example through agreements on land use, housing and transport (MAL). The aim is to ensure that projects promoting walking, cycling and public transport will be prioritised in urban transport planning and project funding. • The location of jobs and services in growing urban regions will be steered towards regional centres, subcentres and public transport nodes with a high service level. • Infill construction, the creation of locations that are good for the urban structure and the use of such locations for new construction will be promoted in urban areas. • The joint programme of the State and urban regions for the promotion of walking and cycling will be implemented in 2018–2022. • Park-and-ride facilities for bicycles will be developed in transport nodes. • Station areas will be developed through market experiments and urban development pilots.
KAISU/Agriculture	• Growing crops in organic soils for several years with zero tillage. • Raising the water table through controlled subsurface drainage. • Planting forest and wetland forest in areas with organic soil. • Promoting biogas production.
KAISU/Machinery	• Frontloading the introduction of a bioliquid blending obligation and increasing the blending ratio (for light fuel oil) towards the 10 % target set for 2030. The steering instrument used to accomplish this will be an amendment to the act on promoting the use of biofuels in transport (laki biopolttoaineiden käytön edistämisestä liikenteessä 446/2007). • Promoting the use of biogas in machinery • Increasing the share of energy-efficient and low emission machinery through public procurement. • Promoting the energy-efficient use of machinery through guidance by information.
KAISU/Other energy-related emissions	• Introducing an obligation to blend light fuel oil with 10% of bioliquid and frontloading its implementation. • Promoting the replacement of fuel oil-fired boilers with boilers fired with solid fuel. • Enhancing the efficiency of energy audits in accordance with the policies proposed in the energy and climate strategy.

The EU's National Emission Ceilings Directive (2016/2284) requires each Member State to prepare a National Air Pollution Control Programme. The air pollution control programme includes the measures used to reach the directive's atmospheric emission reduction commitments set for sulphur dioxide, nitrogen oxides, volatile organic compounds, fine particulate matter and ammonia. The air pollution control programme presents the current state of air pollution control in Finland (emissions, air quality, impacts), and a projection of the emissions, impacts and necessary measures by 2030.

According to the calculations by the Finnish Environment Institute, Finland will reach the relevant emission reduction commitments set by the NEC Directive with the measures already agreed in the national energy and climate strategy and the action plan to reduce ammonia emissions from agriculture.

Even though Finland complies with the emission obligations, air pollution continues to cause adverse health and environmental effects. As a result, this programme includes measures that can further improve air quality and reduce exposure. These measures are particularly concerned with emission sources at breathing height (street dust and small-scale burning of wood, exhaust gas) as well as the activities in other sectors that affect air quality.

The air pollution control programme emphasises the importance of taking air pollution control systematically into consideration in all planning and decision-making influencing air quality at all levels of decision-making. Air quality is particularly affected by the transport, energy, climate, agricultural and land use sectors, and in municipalities. The benefits are seen in the welfare sector. Collaborative projects that promote issues such as carbon neutrality and public health usually also improve air quality.

Ympäristöministeriö
Miljöministeriet
Ministry of the Environment

ISBN: 978-952-361-020-0 (PDF)
ISSN: 2490-1024 (PDF)